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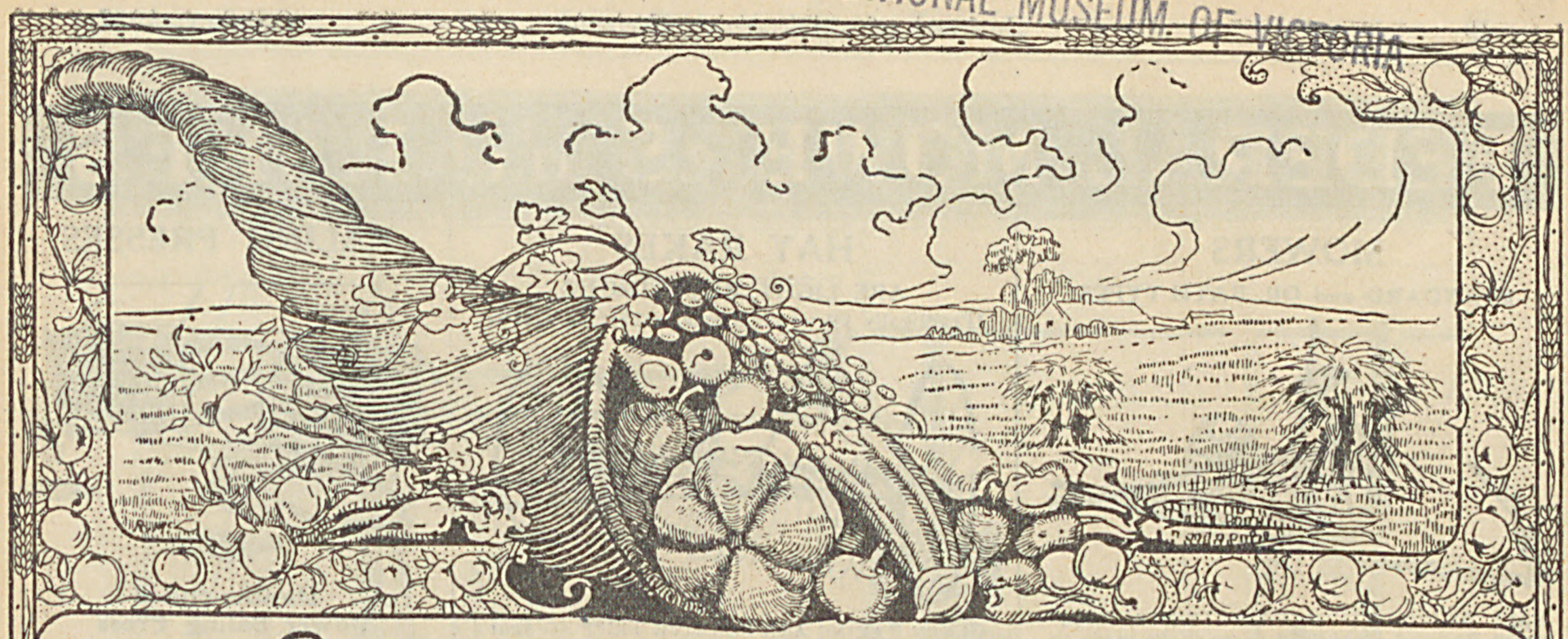

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*Issued under the direction of the Hon. E. J. Hogan, M.L.A., Minister of Agriculture.*


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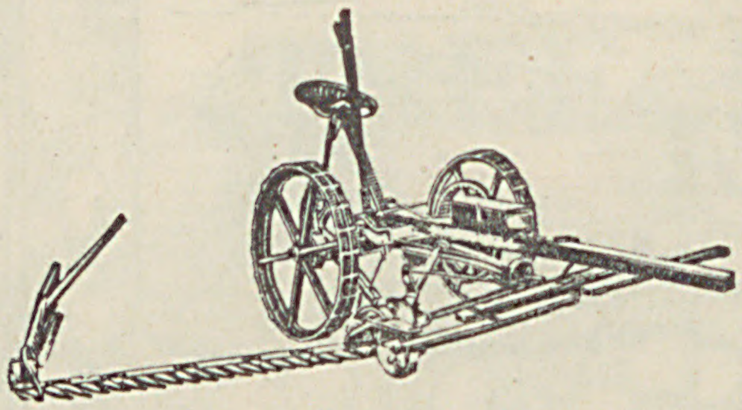

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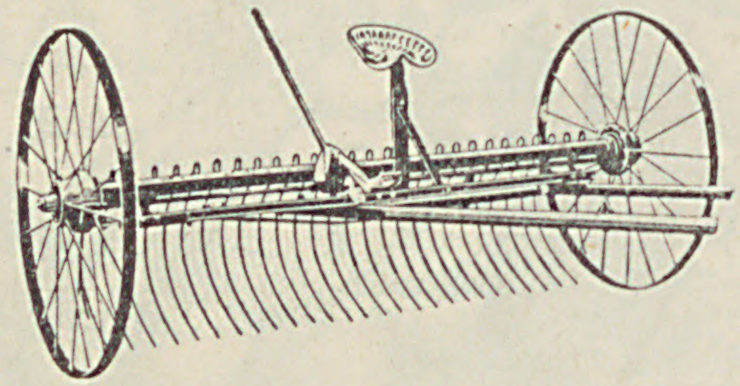

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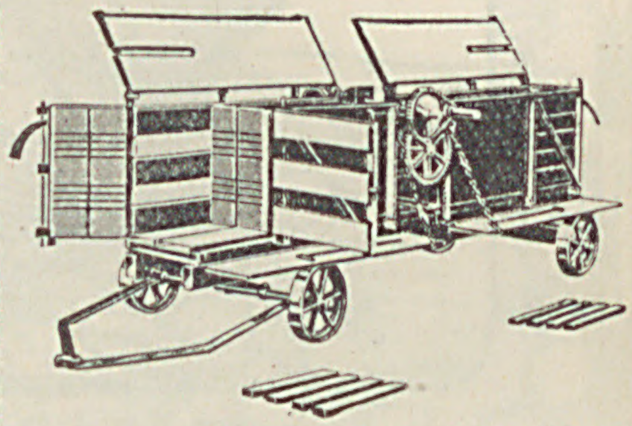

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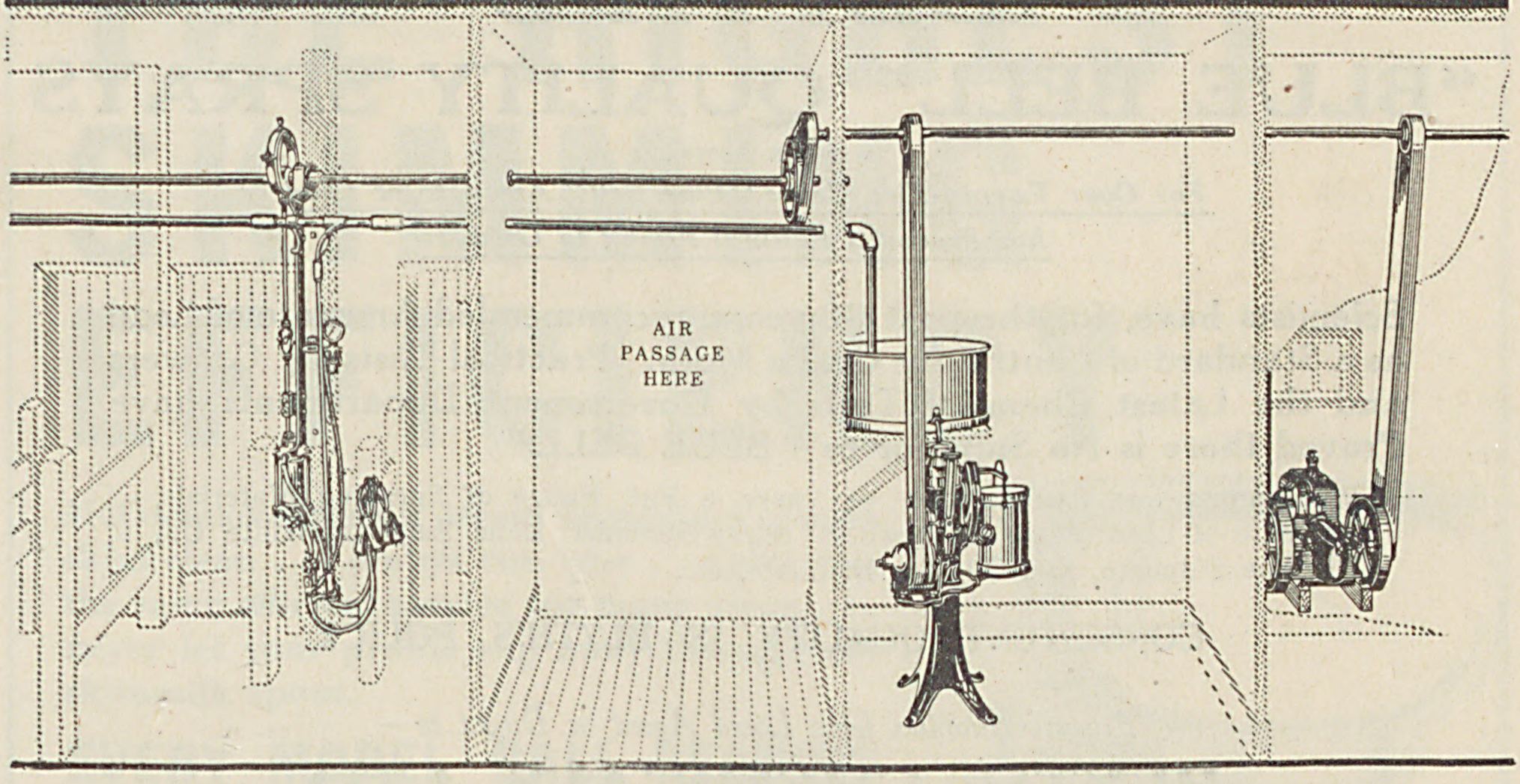


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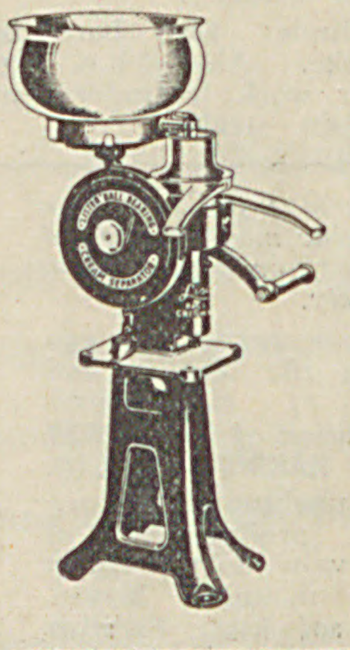

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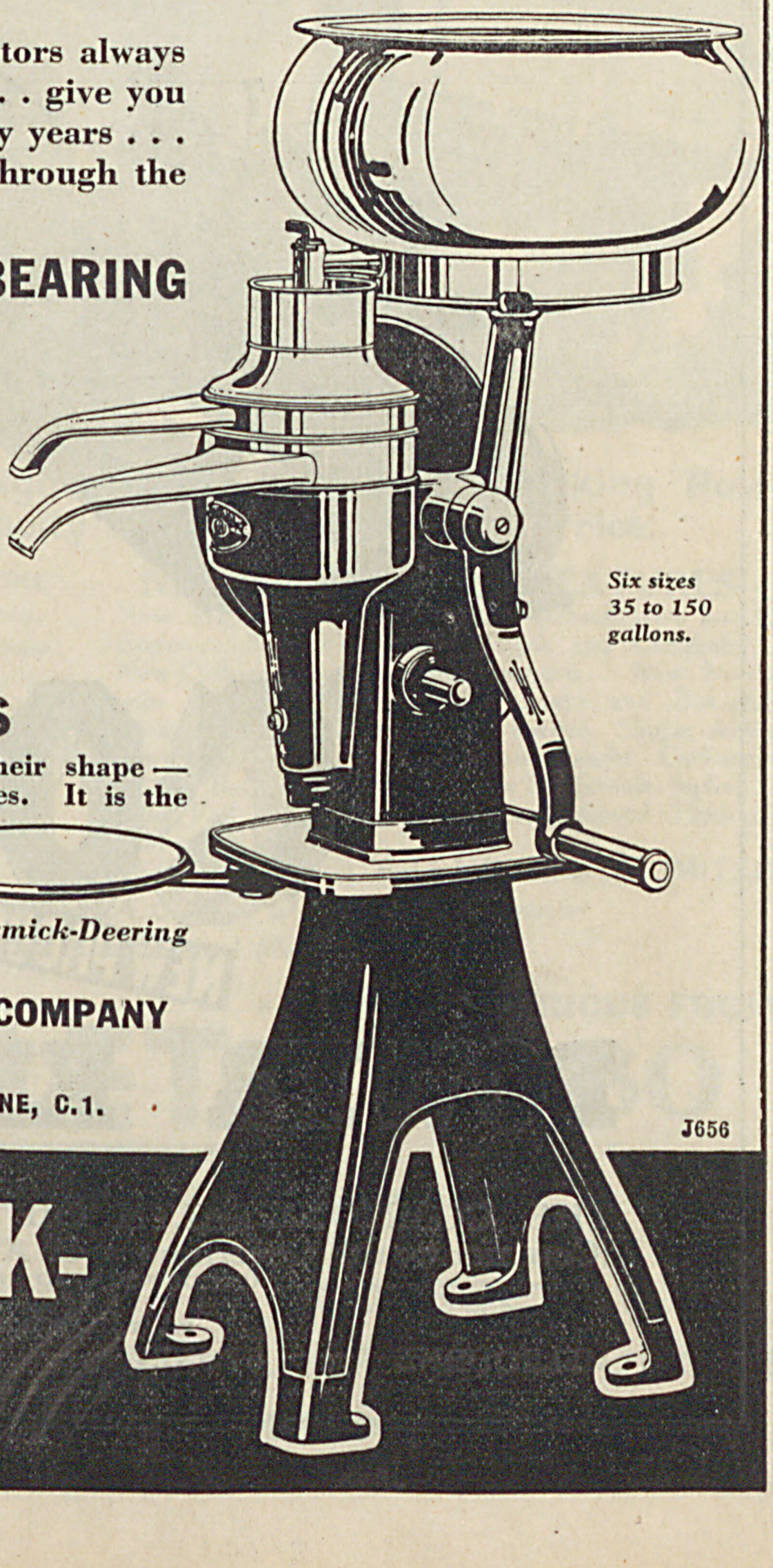

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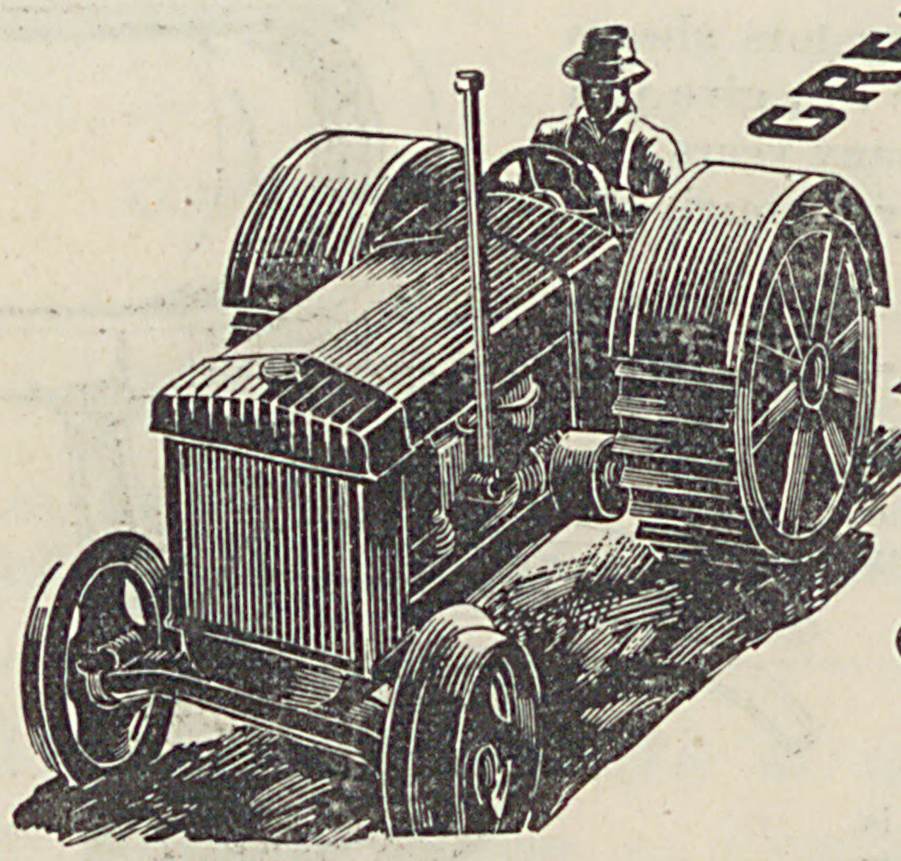

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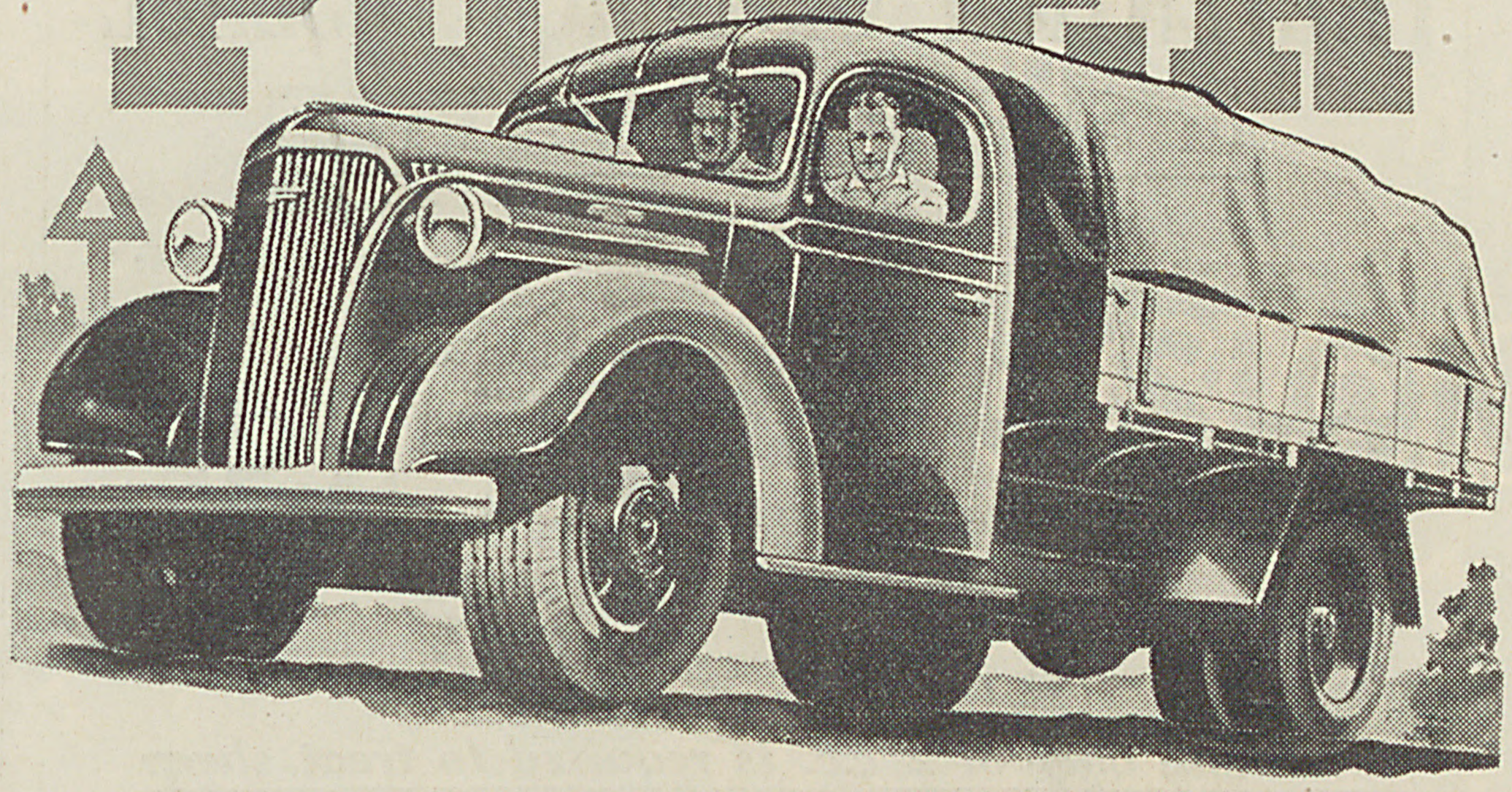

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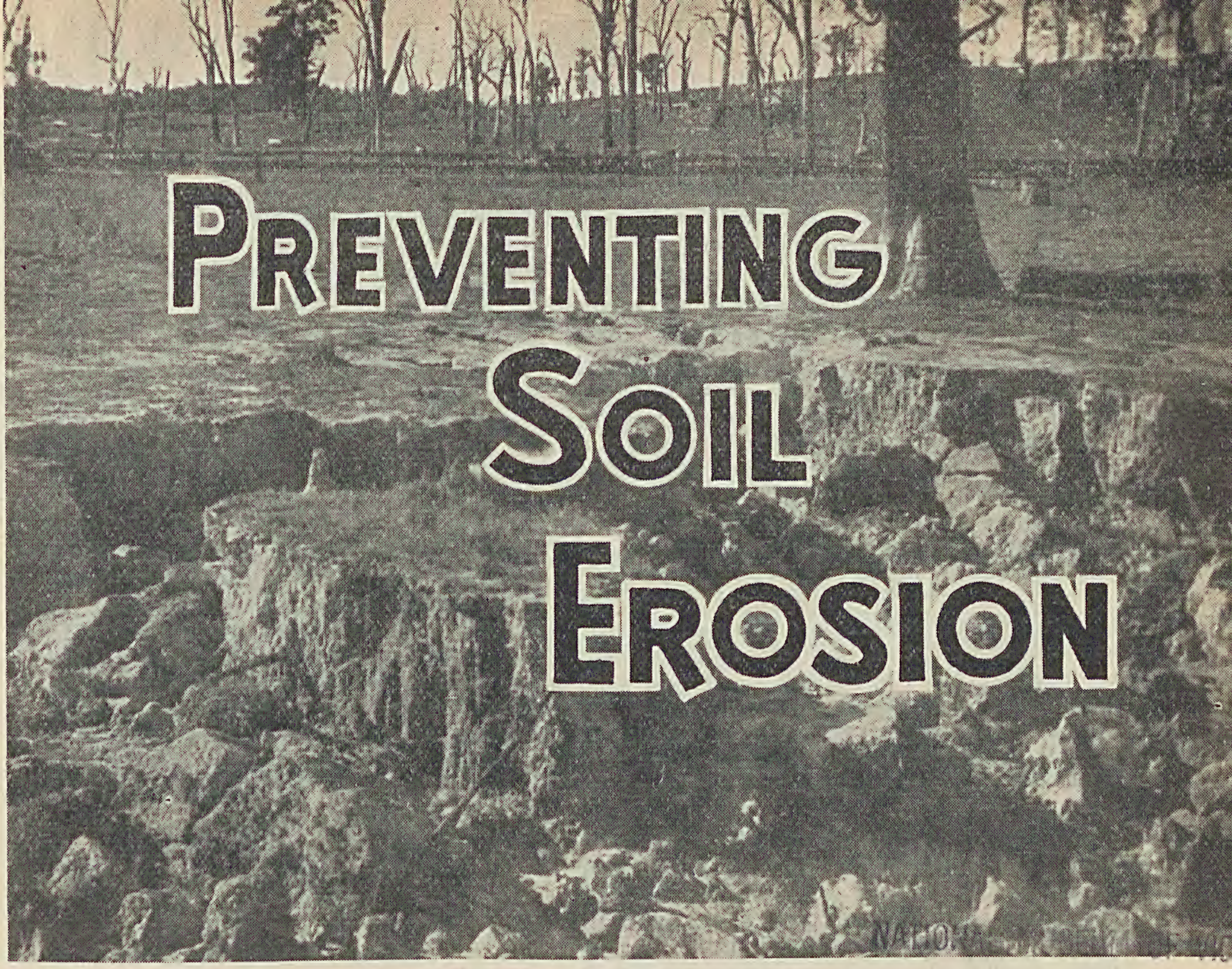


## *The Engineering Side of the Problem*

*By H. G. Strom, B.C.E., Assoc. M.I.E. Aust., Divisional Engineer, Rivers and Reclamation Division, State Rivers and Water Supply Commission.*

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EROSION is the wearing down of the land surface by wind, water, and other forces. It occurs, of course, under natural conditions; but in many parts of the world it has increased in historical times to such an extent as to destroy or damage much valuable land, and to threaten the loss of very much more. In the United States of America the losses of soil have grown to such an appalling extent that the Government has been compelled to embark on a huge programme of anti-erosion investigation and works.

In Australia, which has not been so long occupied by white settlement, the damage by erosion has not reached so advanced a stage, but sufficient is visible to show that, unless the problem is taken in hand, it is only a question of time before the losses here will be as serious as in America. It would be a conservative estimate to say that in Victoria alone over a million pounds worth of land has been lost or seriously damaged, and the process is going on rapidly. The loss in productivity is serious enough to warrant prompt action, and this action must be taken largely by the individual landholders. A landholder who neglects his property penalizes not only himself, but other landholders as well.

Erosion of farm and grazing land manifests itself in four main forms:—

(1) Sheet erosion, in which the topsoil is washed off by water or blown away by wind.
(2) Headward erosion or gullying, in which a steepsided scour or canyon forms in depressions or on a hillside and eats rapidly up the slope. (This is what is referred to in this article as a "gully.")
(3) Lateral or stream erosion, in which a stream widens its bed by washing away its banks.
(4) Landslides, by which areas of soil on steep hillside country slip towards the valley.

The control of erosion is effected by a combination of methods :—

(*a*) Avoidance or correction, as far as possible, of conditions causing erosion, and

(*b*) Provision of works to hinder or prevent erosion.

The latter may be effected by using natural means (growth of vegetation), artificial means (check dams, &c.), or usually, a combination of both. In other words, the control of erosion is a combination of agricultural and engineering methods. It is proposed herein to deal mainly with the engineering aspect of the problem. The even more important agricultural aspect is only touched on incidentally.

The control of type (1), sheet erosion, is largely a matter of land utilization or farming practice, and it is not proposed to discuss it here, except to mention that overstocking of grazing land should be avoided ; that steep land should not be cultivated ; that sloping land should, if possible, be ploughed across the slope ; and that thick scour-resisting pastures are encouraged by top-dressing.

The control of type (3) or stream erosion is usually too difficult and costly for the landholder to undertake. (It may be mentioned, incidentally, that if a landholder in Victoria is losing land through a stream eroding its banks, he may apply, through the local Shire Council, for a grant from the Rivers and Streams Fund towards the cost of works to prevent it. These grants are made on a contributory basis, at present £1 from the Fund for each £1 contributed by the landholder in cash or labour). Erosion of the fourth or landslide type is usually extremely difficult to control.

Type (2), or gullying, can largely be controlled by the landholder. The object of this article is to suggest various methods by which the landholder of average ability and industry may check or cure gullying of his land. It must be understood that no method is infallible, and the choice of method must be governed by the circumstances of the case. The methods indicated have, however, been used in Victoria and elsewhere with general success, and if carried out thoroughly and intelligently should give worthwhile results.

### *Why Gullying Should be Checked.*

From the landowners' point of view, the main damage caused by gullying is usually the loss of areas of fertile topsoil. This is the more serious as the parts most affected are usually the deeper soils along the valleys and hillflanks which have been formed by the wash from higher lands. Other harmful effects, however, are often in evidence, of which the following may be mentioned :—

(*a*) Gullies cut across roads and tracks, interfering with the passage of vehicles and implements, and often rendering necessary the construction of culverts or bridges.

(*b*) They undermine and destroy fences, making it difficult to keep fences stockproof and rabbitproof unless extra trouble and expense are incurred for fence-crossings.

(*c*) Where gullies occur in cultivated areas, they cut the paddocks into awkward shapes, interfering with working and making it necessary to leave part of the land idle.

*Fig. 1.—Small break in wide grassy valley near the Omeo-Bruthen road at Tongio Gap. Unless checked, this will develop like the gully in Fig. 2. Fig. 2.—In the same valley as Fig. 1, just across the road. This gully is nearly 20 feet deep and steadily extending.*

*Fig. 3.—Gully near Bethanga, where a small stream is cutting back to form a canyon; this is only a few miles from the Hume Storage. Fig. 4.—Gully near Omeo, in metamorphic and granitic country, with typically friable subsoil; note how tree roots have held position of bank. Fig. 5.—Scour in grassy slope formed by wash from granite hill, near Towong, Upper Murray; this huge gash is rapidly being enlarged by stormwater passing over the edge and cutting away the sugary subsoil, undermining the tougher top layer. Fig. 6.—Near Benambra; scour eating its way up a cleared valley of gentle slope.*

(*d*) They bring down the subsoil from the slopes on to the flatter lands below, often covering good land with barren sand or clay.

(*e*) When deep, with steep crumbling sides, they are a danger to stock.

(*f*) Where they cut through deep alluvial soil, they act as a drain, leading away water which otherwise would be retained in the soil. In some cases this may be a benefit, but in the drier areas it is usually harmful. They may even cause the drying up of springs.

(*g*) They make a farm look unsightly, giving an impression of "bad farming," and lessening the market value.

Quite apart from these direct losses to the individual landholder, moreover, there is the general consideration of increased flooding, choking of streams, and damage to public roads, with the resultant tendency to increased shire rates.

For all these reasons, it is important that gullying should be checked as soon as it commences and before it gets out of hand.

## *Hydraulic Principles.*

A brief statement of the hydraulic principles underlying erosion and its cure may be given here.

Where water flows down a sloping channel—

(1) Other things being equal, the steeper the slope the faster the water will flow down it;

(2) The smoother the channel and the fewer the obstructions in it, the faster the water will flow;

(3) The same volume of water will flow faster down a narrow deep channel than down a wide one;

*Fig. 7.—Road in granite country near Eldorado; traffic is light, but has been sufficient to start scour.*

*Fig. 8.—Gullying on wheat field, near Wychitella. Fig. 9.—The same type at a later stage.*

(4) In a similar channel, a larger stream will flow faster than a small one ; and

(5) The erosive power of water increases enormously with increase of speed ; doubling its rate of flow gives a stream sixty-four times as much power to transport material.

Rain falling on sloping land has a certain further vertical distance to pass through before it reaches the foot of the slope. It is this " fall " or " head " which gives it energy to flow. When a hillside is covered with trees and scrub, these, with the leaf-litter from them, obstruct the run-off of stormwater, thus using up much of this energy, reducing the speed of flow and hence the power of the water to scour the soil (law 5 above). This anti-scouring action is assisted by the roots, which bind the soil and so further resist erosion.

When the slope is cleared of scrub and timber, however, much of the obstruction to flow is removed, and so the rate of run-off is increased (law 2). This increases the power of the water to erode. Further, the water concentrates in the streamlines faster, so that the streams have larger flows of shorter duration, still further increasing the rate of flow.

To stop erosion along a gully, therefore, we have to reduce the rate of flow of the stormwater in it to a non-scouring velocity. To do this we have to provide some way of using up the excess energy of the stream which gives it power to erode. One way is to divert the water into a channel of flatter grade, so as to give it a longer travel for the same fall. This is not always convenient, however, and usually the most practical way is to provide obstructions along the present channel. Ultimately, this must be done by growing vegetation along the gully—trees, shrubs, vines, or tough-rooting grass. It is, however, often difficult to get plants to grow in scouring soil, so we must first provide means of temporarily checking the scouring action.

### *How Gullies Extend.*

The process of gullying varies somewhat in different types of soil. Usually a scour starts at the lower end of a slope and works upwards. Occasionally a small pothole will form in the bottom of a grassy valley. (See Fig. 1.) In

*Fig. 10.—Although this slope near Castlemaine is not now cultivated, the gullying goes on.*

either case once the surface is broken, a small waterfall occurs at the upper end of the break. This deepens the hole till the unprotected subsoil is reached. If this is of a sandy or friable nature (as for instance in much of the north-east of Victoria), it rapidly scours out, so undermining the tougher layer of surface sod, and extending the scour uphill, forming a gully. As the bed of this gully usually forms a flatter grade than the original surface, the scour deepens as it works uphill, until it may be twenty feet deep or more at the head. Even a small trickle of water falling sheer through this height is sufficient to keep the scour going. (See Figs. 2 to 6.)

Meanwhile, the concentrated rush of storm-water along the gully widens and deepens it. Logs and other obstructions divert the current into one bank or other, increasing the widening action. Water running over the sides of the scour causes smaller branch gullies to extend in the same manner as the main one. This type is common in the Omeo and Upper Murray districts, and generally in cleared grazing country on foot-hill slopes with deep "sugary" subsoil.

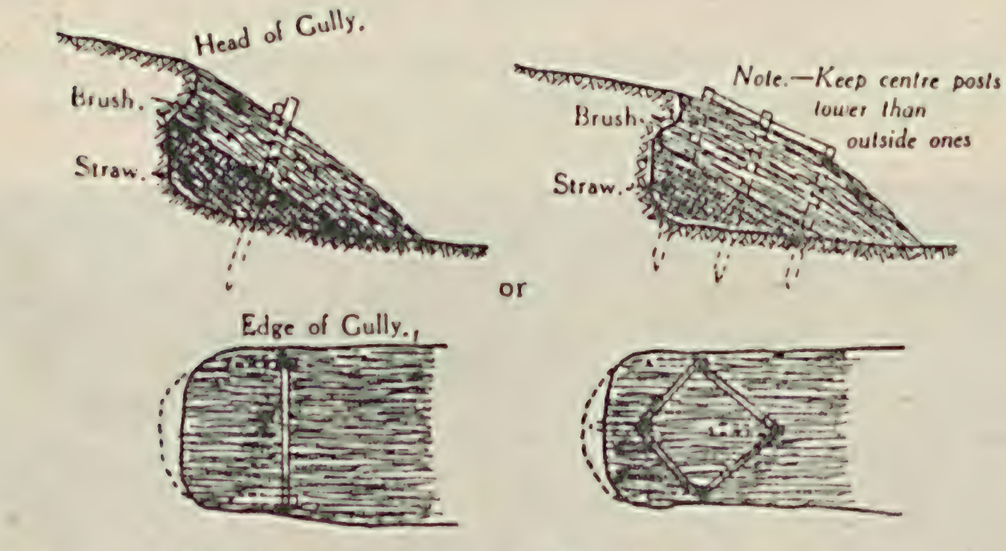
Where the subsoil is tougher, or where the surface is loosened by cultivation or by traffic, the gullies often take a different form, commencing as small furrows, which join to make a larger gully, steadily enlarging as it passes down the slope. (See Figs. 7, 8, 9, and 10.) In its initial forms, this is really a development of sheet erosion, and should be countered in the same way. Examples of this type may be found in the wheat country near Wychitella and Charlton.

### *Checking Erosion at Head of Gully.*

Where the head of a gully is cutting back rapidly in an abrupt drop or overhanging face, the first thing to do is to prevent the gully extending, before attempting to cause it to silt up. The problem is here to get the water from the surface of the ground to the bed of the gully without scour.

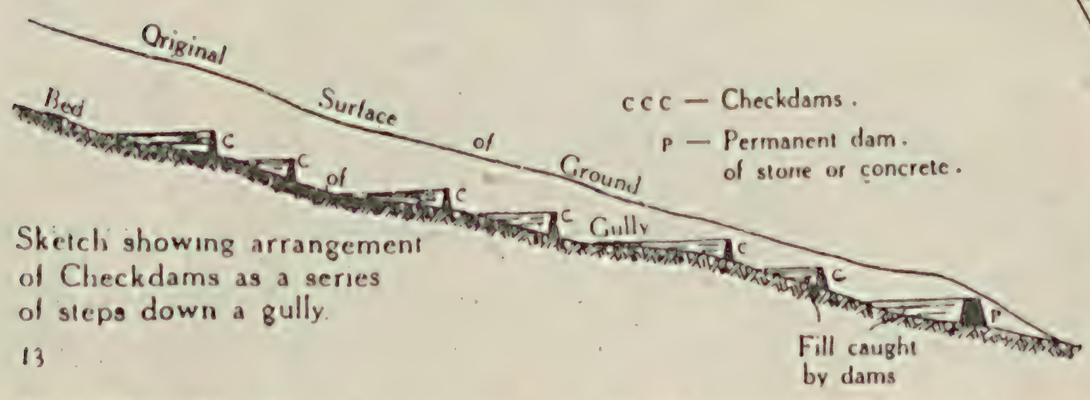
In the case of gullies only a few feet deep, or where the catchment above is small, scour may be checked with straw and brushwood fastened just under the drop at the head. (See Fig. 11.) Two posts are set firmly in the ground, one near each wall of the gully; a thick layer of straw is packed round the posts and against the head of the gully, with few branches laid in it to hold it together; on this is packed a thick layer of brush, nearly to the top of the bank, and finally a crosspiece is fixed to the posts to hold the brush in position. The brush breaks up the falling water and dissipates its energy, and the straw prevents undermining. This should hold the head of the gully while checkbanks and vegetation are being established lower down. This may also be used to check side gullies which are developing off the main one.

In the case of deeper gullies, more elaborate methods may be necessary. One method is to cut the head bank of the gully back to a slope of about 1 in 2, and to install a flume of wood, galvanized iron, flat stone pitching grouted with cement, concrete, or other non-scouring material. For small gullies, even tough sod will do. Care



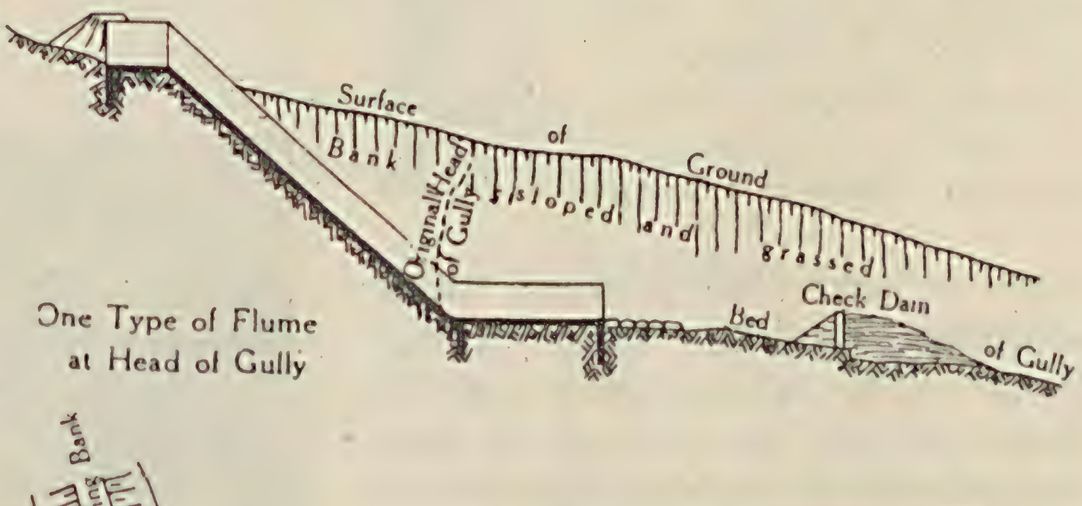

Sketch showing Straw and Brush used to check extension of Small Gully

11




Sketch showing arrangement of Checkdams as a series of steps down a gully.

13




One Type of Flume at Head of Gully

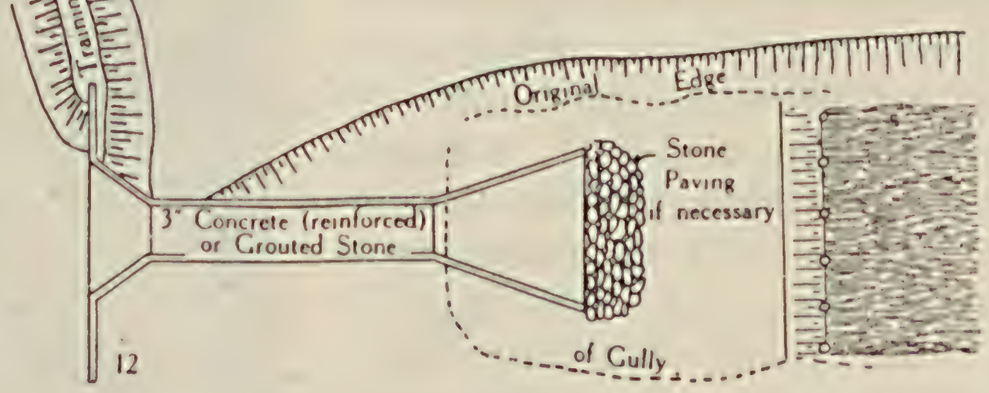



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***Fig. 11.—Showing how straw and brush may be packed into the head of a small gully or pothole. Fig. 12.—Diagram showing flume and checkdam at head of gully. Fig. 13.—Diagram showing series of checkdams down a gully.***

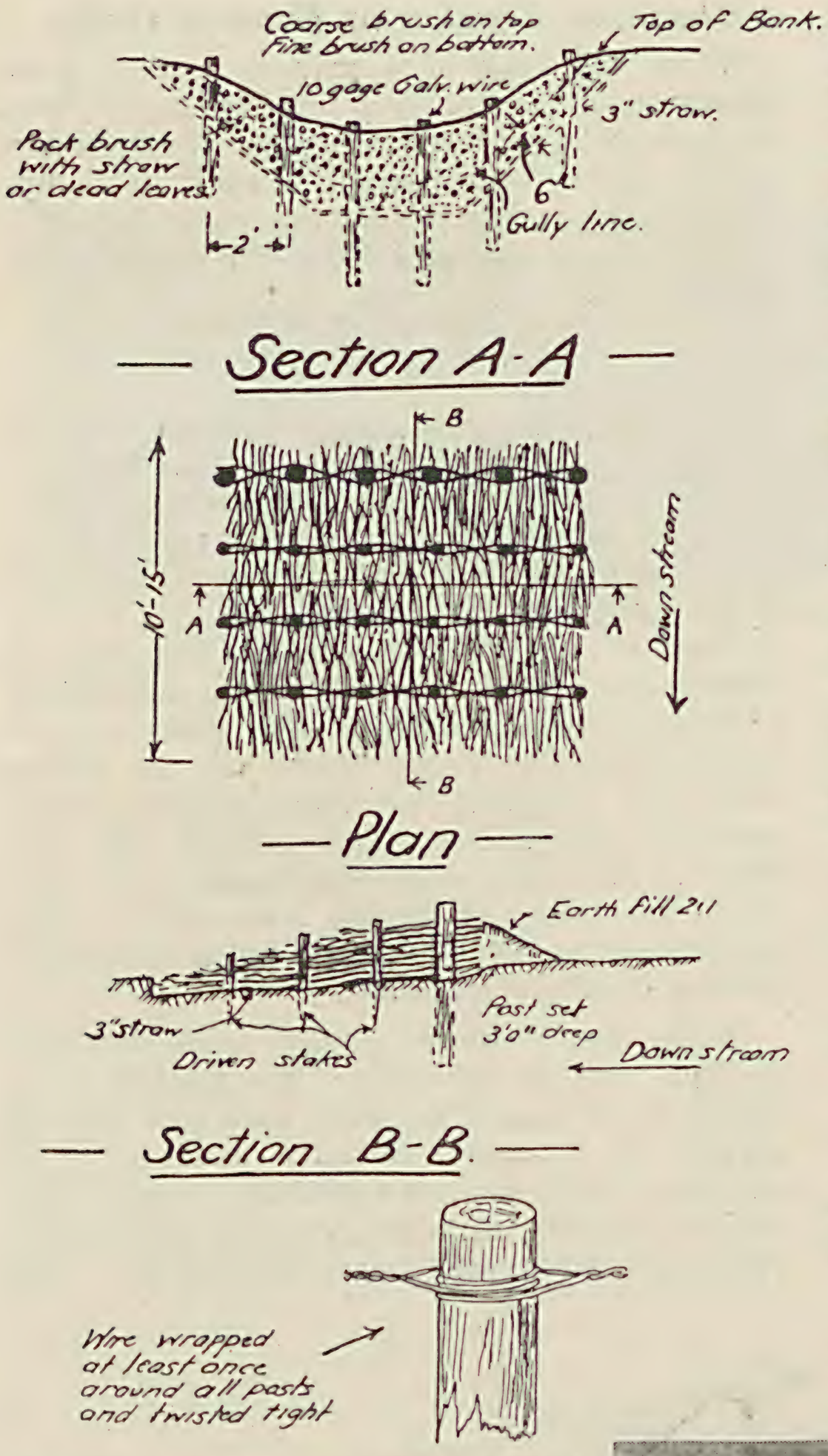


***Fig. 14.—Single row type post and brush dam.***

must be taken to prevent water scouring round the head of the flume. The lowest few feet of the flume should be bent flush with the gully floor, baffles, or an apron of stone, brush, &c., being provided to prevent the rush of water scouring the bed. A check dam a few yards below the bottom of the flume will be useful, providing a stilling pool. (See Fig. 12.)

A better, though more expensive method, is to build a watertight dam a few feet below the head of the scour, so as to catch silt. Rubble masonry will serve up to about 8 feet, especially if bound with a wire mesh wrapping, but above this height an earth dam, with a drop inlet leading to a pipe through the dam on the level of the gully floor, is probably the cheaper. In either case a protective apron should be provided on the downstream side of the dam. Concrete makes a good dam, if suitably designed, but may be expensive. The dam should in any case be taken well into the bottom and sides of the gully to prevent water scouring round it, and, as for every dam, ample spillway capacity for the largest flow to be expected should be provided.

Training banks should be installed on the land surface above the gully to bring all the water in the gully catchment into the flume. Where several gullies are adjacent, it may be possible to protect one main gully and divert into it the water which would otherwise flow down the others.

Having protected the head, we may now attempt to heal the scour along the gully, and, possibly, to cause it to fill up.

## *Checkdams.*

A dam built across a gully will have the effect of lessening the slope of the water surface upstream; this will check the velocity (law 1), and hence lessen the power of the stream to carry material (law 5), so that the water will be forced to drop some of its load of silt. In time, if the dam does not fail, the gully upstream from the dam will thus silt up to the top of the dam.

By building at suitable intervals along a gully permanent dams of stone or concrete, or of earth with protected spillways, it would be possible in

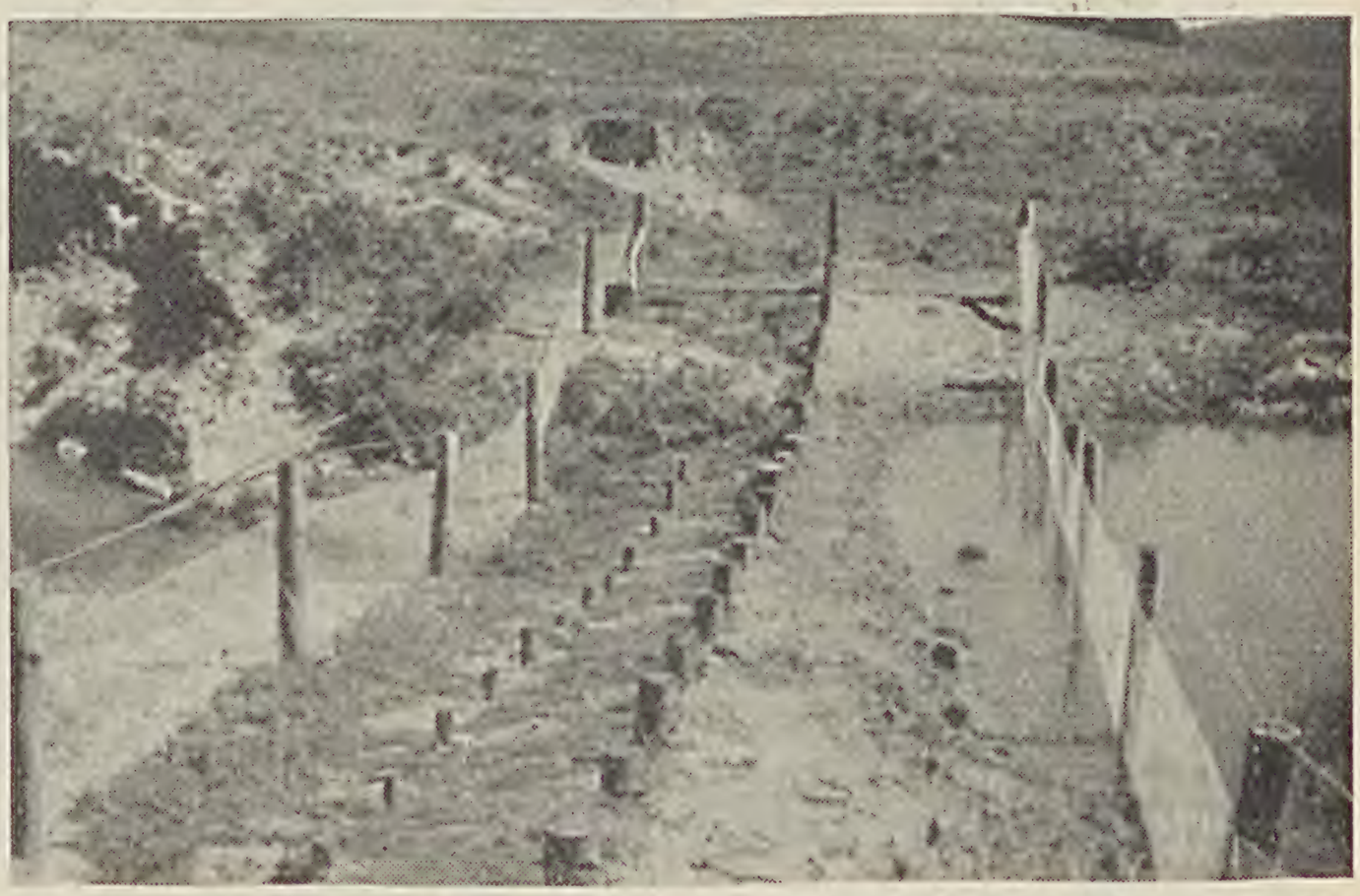

***Fig. 15.—Single row post dam—Skull Creek, Gippsland. This is one of a series installed to prevent damage to road and river flats by siltation.***

time to cause the whole gully to fill up. Such dams are called "soil saving" dams. In the case of large, steep gullies, however, the cost of this method would be too great.

A cheaper method is to install a series of small dams, each a foot or two high, so as to break the fall down the gully into numerous small falls, each of controllable size, like steps in a flat staircase. (See Fig. 13.) In the silt caught by these dams, vegetation is planted, which binds the silt already deposited and helps to catch more. For this purpose, trees may be used, such as willows, (if the ground is moist enough), black locust (*Robinia pseudacacia*), poplars, &c., shrubs, rushes, or grass. When one lot of dams silt to the top, another series can be installed, and so on till the gully is filled to the desired level.

These checkdams, as they are called, can be made of much less expensive materials than the larger soil saving dams, as their main purpose is to delay scour pending the establishment of the vegetation, which will be the permanent protection, and thus they need be of only temporary construction. The spacing of these checkdams, should, if possible, be such that the top of each

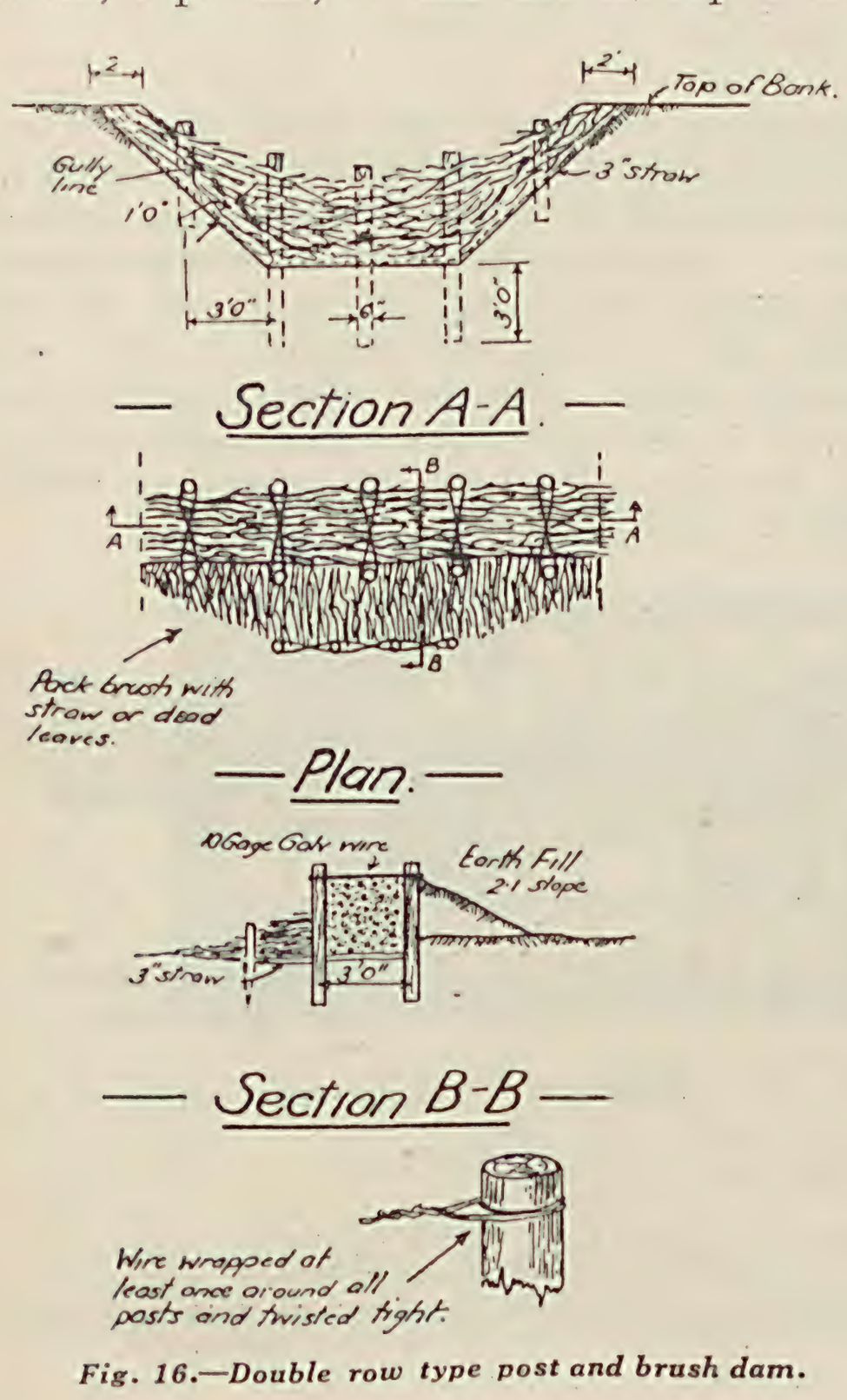


*Fig. 16.—Double row type post and brush dam.*

*Fig. 17.—Double row type post and brush dam at Skull Creek.*

is only a few inches lower than the bottom of the one upstream. If the gully be not too deep, the sides of it may be "battered" or sloped down, so that grass or other plant-growth may be established.

The gully should, if possible, be fenced off to give the plants a chance to grow, as otherwise they may be destroyed by stock before they are properly established.

A common cause of failure of checkdams lies in building them with a level crest or with too small an overflow capacity, with the result that, in a big flow, the water scours the earth at the side of the dam and gets round it. The ends of the dam should be higher than the middle, enough to prevent them being overtopped by stormflow, and should also be taken well into or along the sides and bottom of the gully, to prevent outflanking or underscour. There should be sufficient anchorage to prevent the dam washing away by the pressure of water.

An apron or platform should usually be provided below each dam to catch the water falling over the top and lead it away without scour. This may be of brush staked to the bed, heavy stones, or anything else suitable. The dam furthest downstream in a series should preferably be of permanent material, stone, or concrete.

### *Types of Checkdam.*

The following are a few types of checkdams which have proved useful in Victoria and other countries in gully control, and which can be constructed by the average landholder at comparatively small cost for material. Other types may suggest themselves to landholders, or others interested, according to local conditions and materials available. The general principles in all cases are the same.

#### (1) Brushwood Dams.

(*a*) **Single-row Post Dam,** with longitudinal brush. (Figs. 14, 15.) This is suitable for small to medium gullies up to say 10 feet wide. First

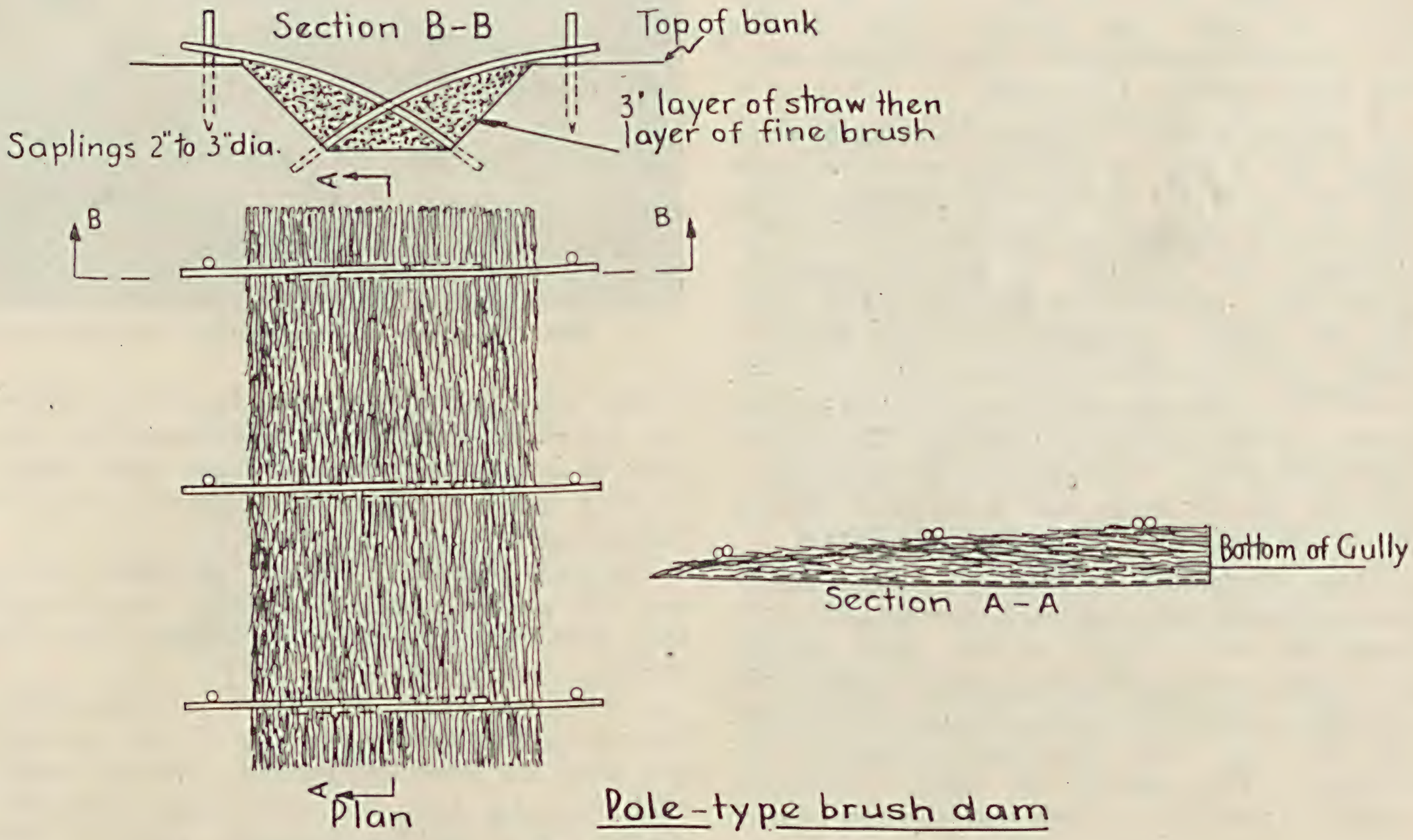


*Fig. 18.—Pole type brush dam.*

cut the sides of the gully at the site of the dam down to a slope of 1 in 1 or even flatter. Next dig out the bottom and sides of the gully to a depth of 6 inches or so, throwing the earth upstream. Set stout posts in holes 3 feet deep about 2 feet apart, tamping the earth well round the posts. Put a layer of straw, dried grass, &c., all over excavation, then lay branches, butts upstream, on the straw, longest underneath and shorter as the pile grows. Each layer of branches should be tramped down when laid. Where available, any forks on the branches should be hooked round the posts, or round wires between them. Any large space between branches should be packed with straw. Wires should be run along the line of posts, secured to each, and twisted tightly. The earth from the excavation should be built into a bank against the butts of the branches. If it can be grassed or sodded over so much the better.

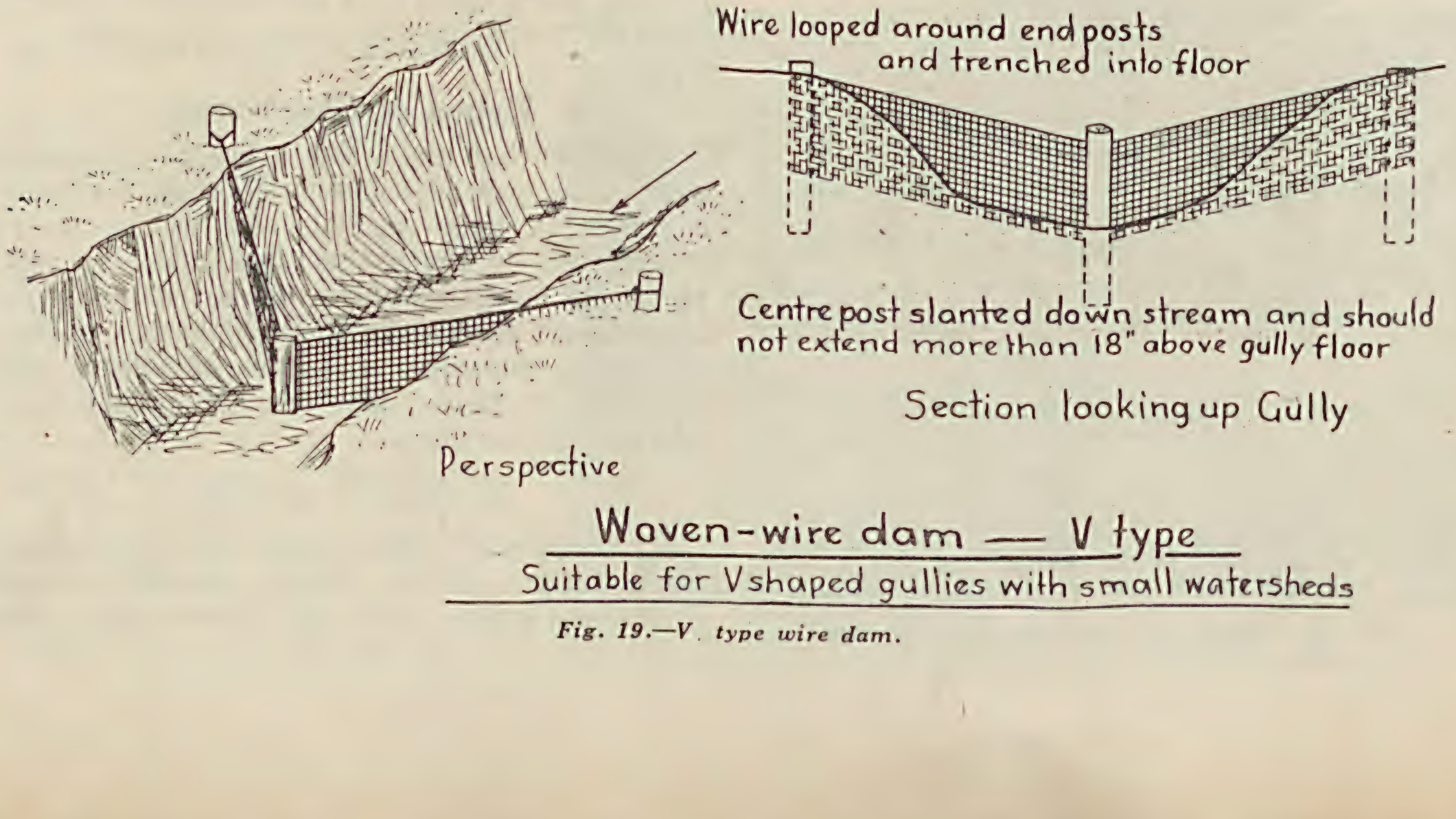
Wire looped around end posts and trenched into floor
Centre post slanted down stream and should not extend more than 18" above gully floor
Section looking up Gully
Perspective
Woven-wire dam — V type
Suitable for Vshaped gullies with small watersheds

*Fig. 19.—V. type wire dam.*

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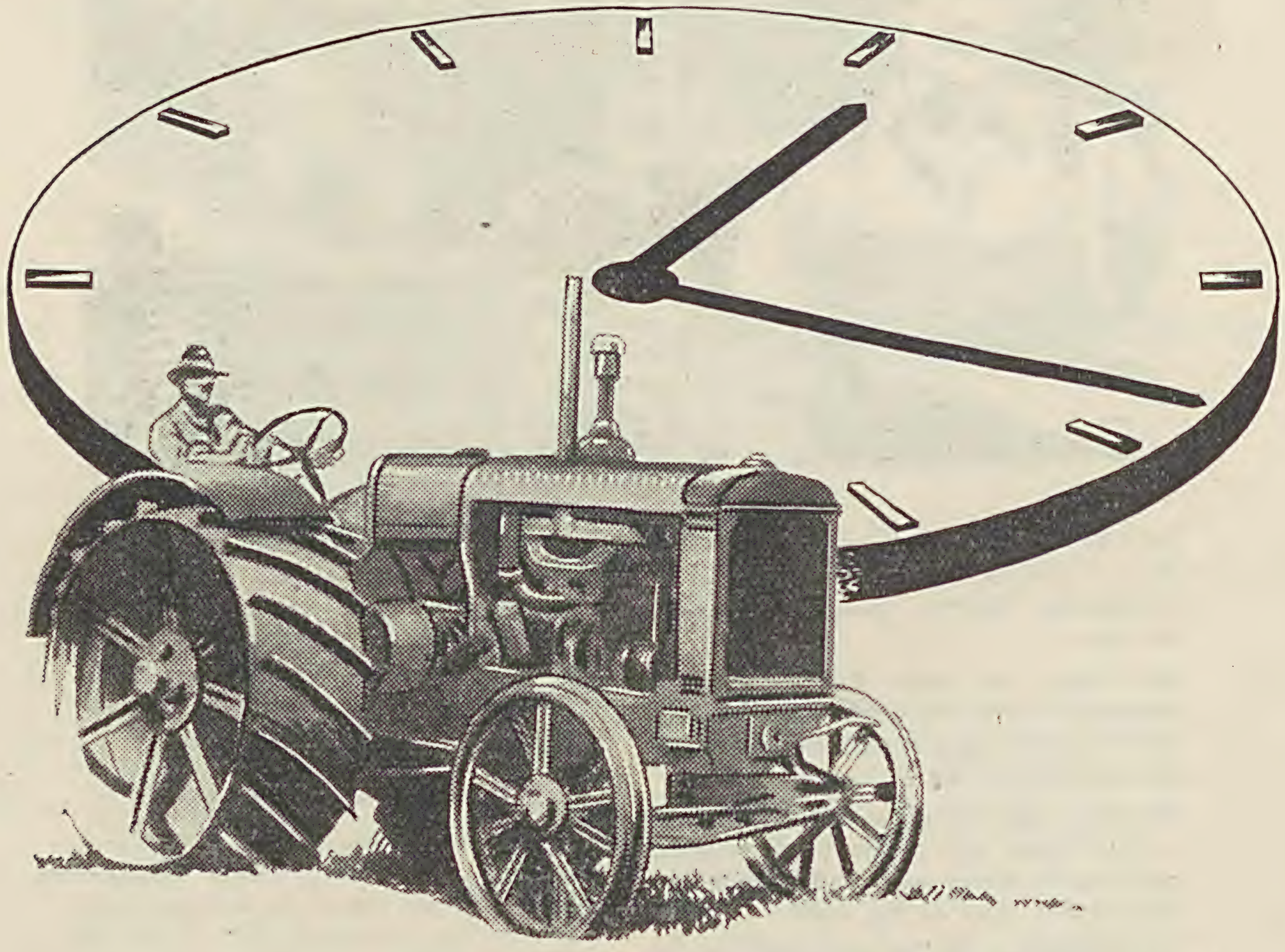

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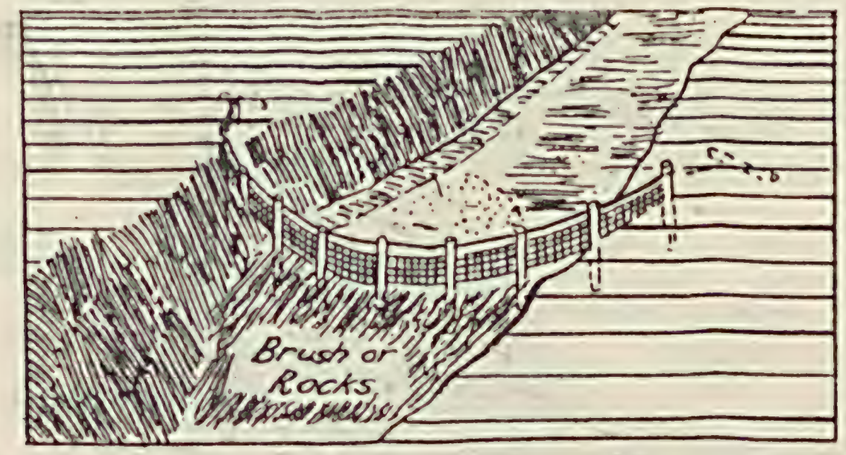
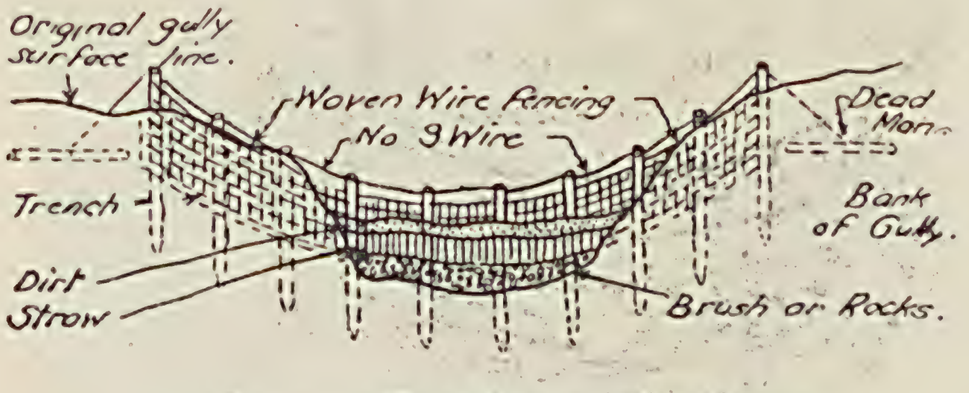
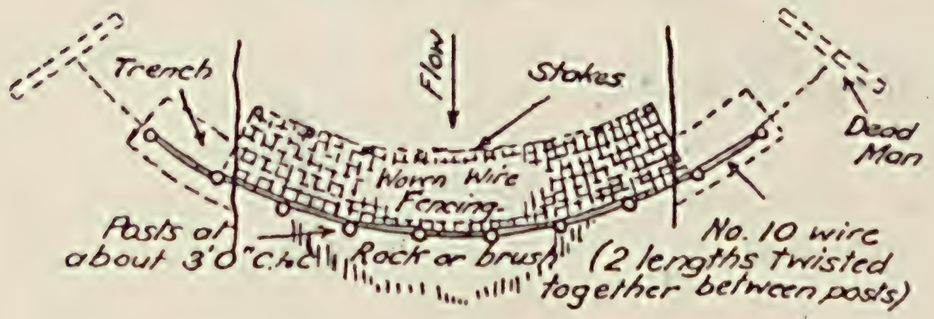



— Perspective. —




— Cross Section A-A —

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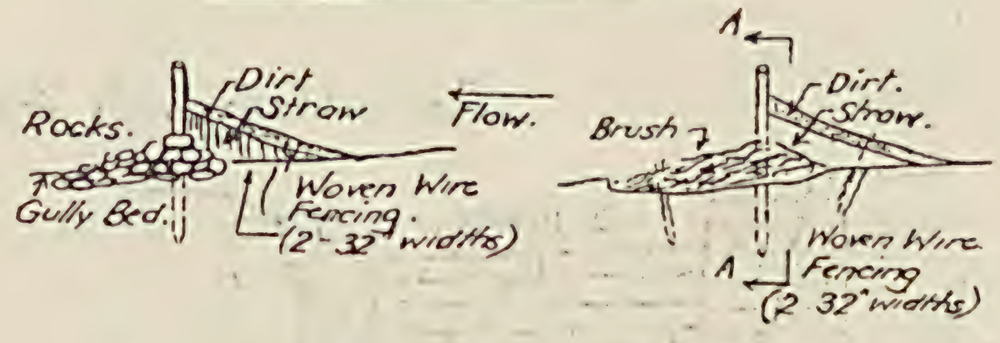


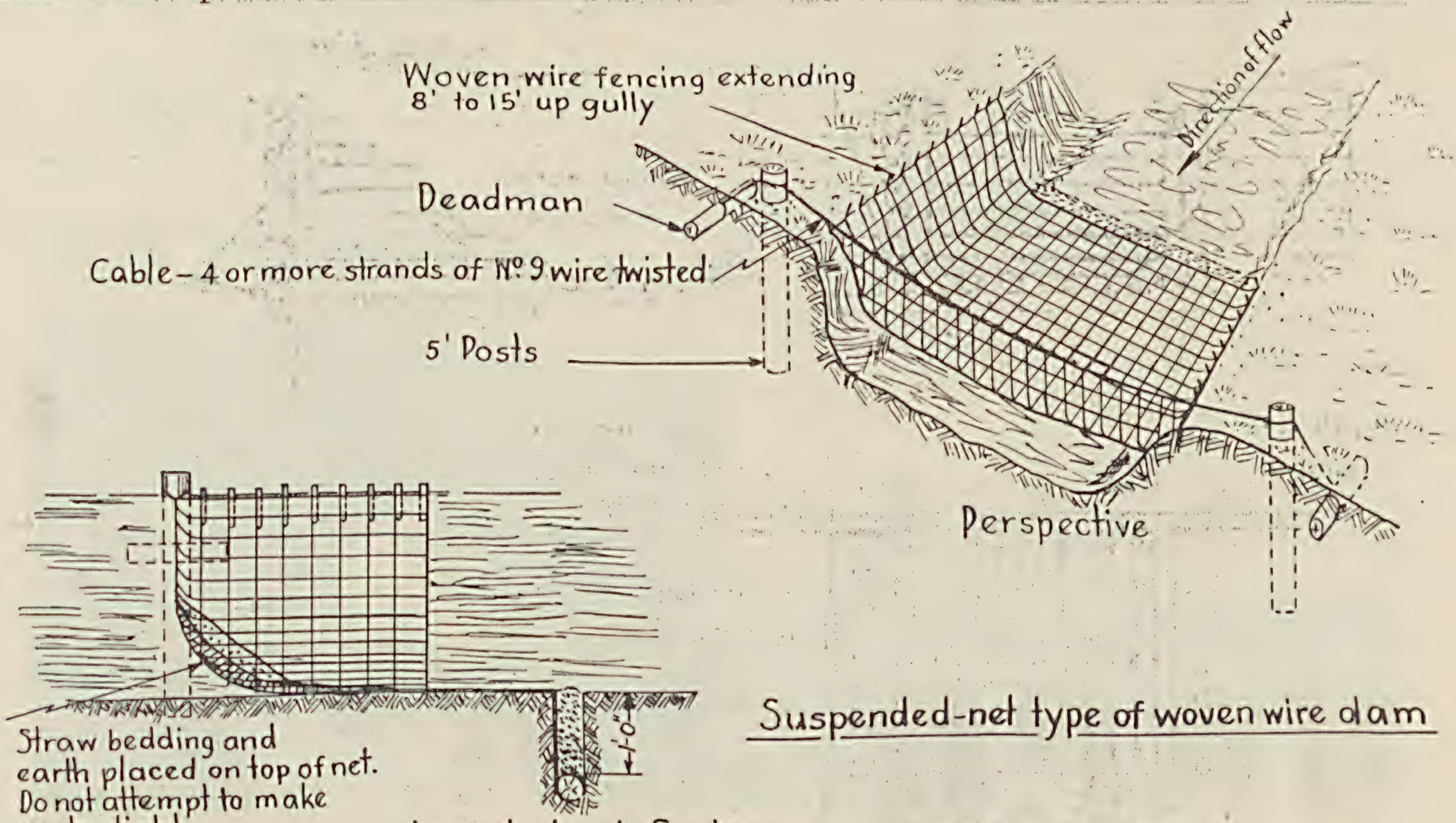

— Longitudinal Sections —

***Fig. 20.—Fixed basket wire dam.***

Some shrinkage will take place as the brush dries. Smaller stakes, connected by wires, should be driven in rows across the brush, and driven deeper as the pile shrinks.

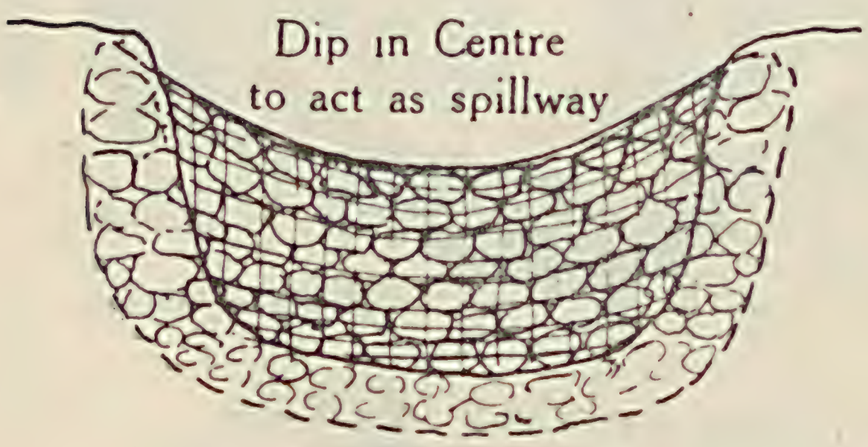
(*b*) **Double-row Post Dam.**—(Figs. 16, 17.) Here two rows of posts are used, and brush is packed between them crosswise to the gully. The posts are set and tamped as before, but about 3 feet apart in the rows, which are also 3 feet apart, the earth between rows being excavated a foot deep, and piled against the front of the dam as before. Line the excavation with straw as before, laying the brush on it. An apron of brush or stones should be provided downstream.

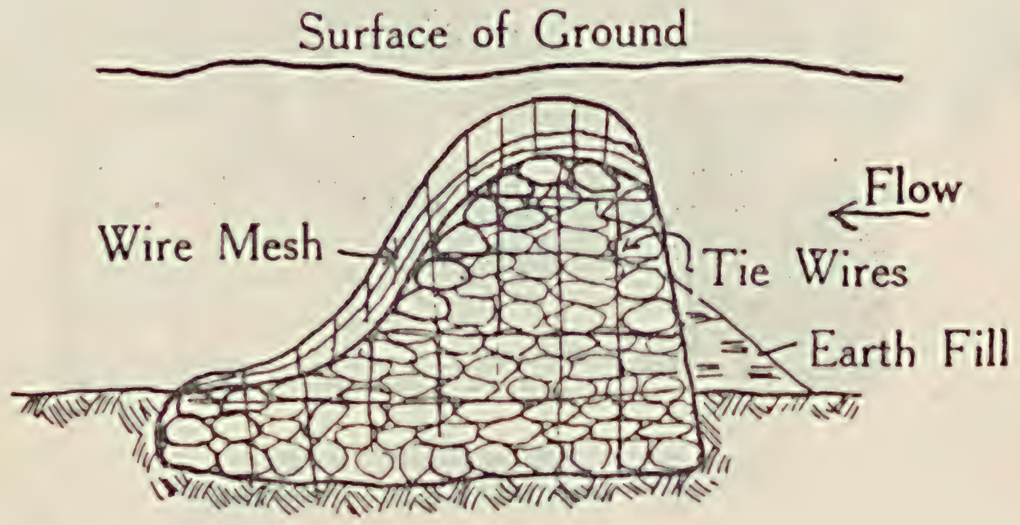
(*c*) **Pole Type.**—(Fig. 18.) Brush is laid longitudinally, and pressed into position by poles with their butts in the bottom of the gully one


Woven wire fencing extending 8' to 15' up gully
Deadman
Cable – 4 or more strands of No. 9 wire twisted
5' Posts
Direction of flow
Perspective
Straw bedding and earth placed on top of net. Do not attempt to make watertight.
1'-0"
Longitudinal Section

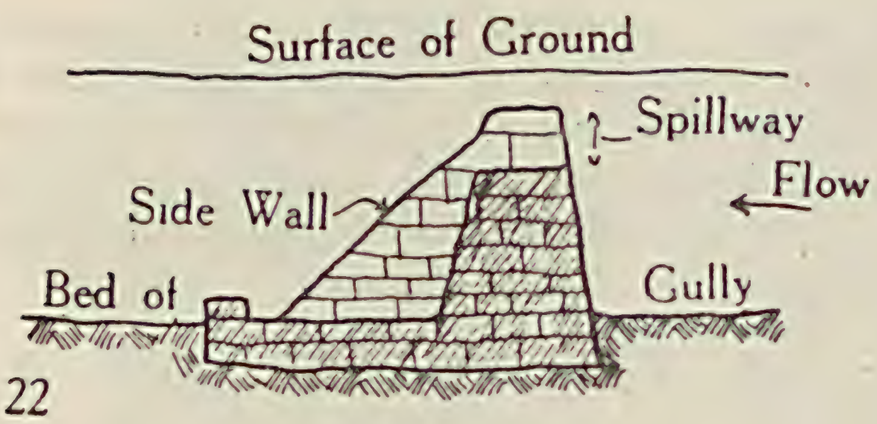
Suspended-net type of woven wire dam

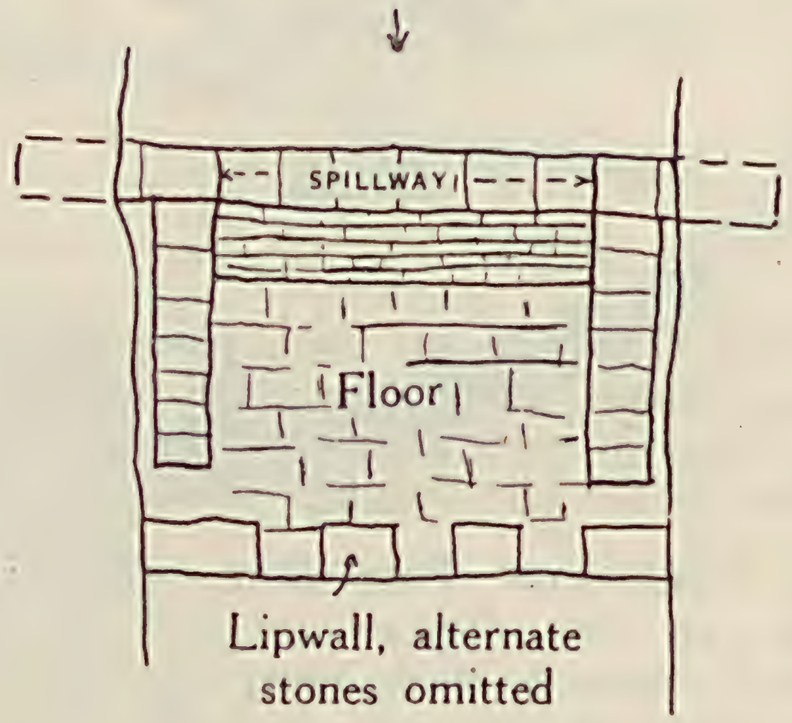
***Fig. 21.—Suspended net wire dam.***




Rock Dam with Wire Mesh Binding

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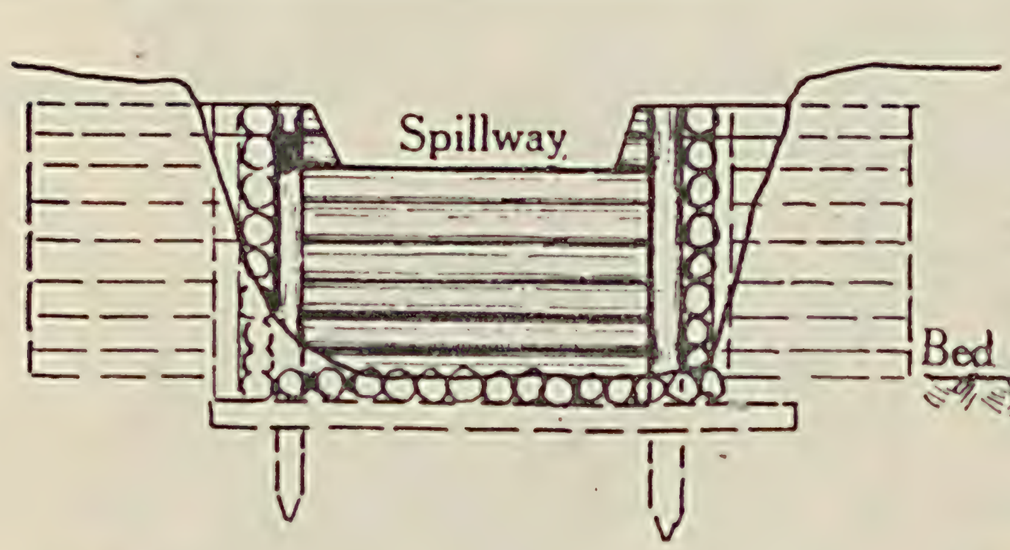
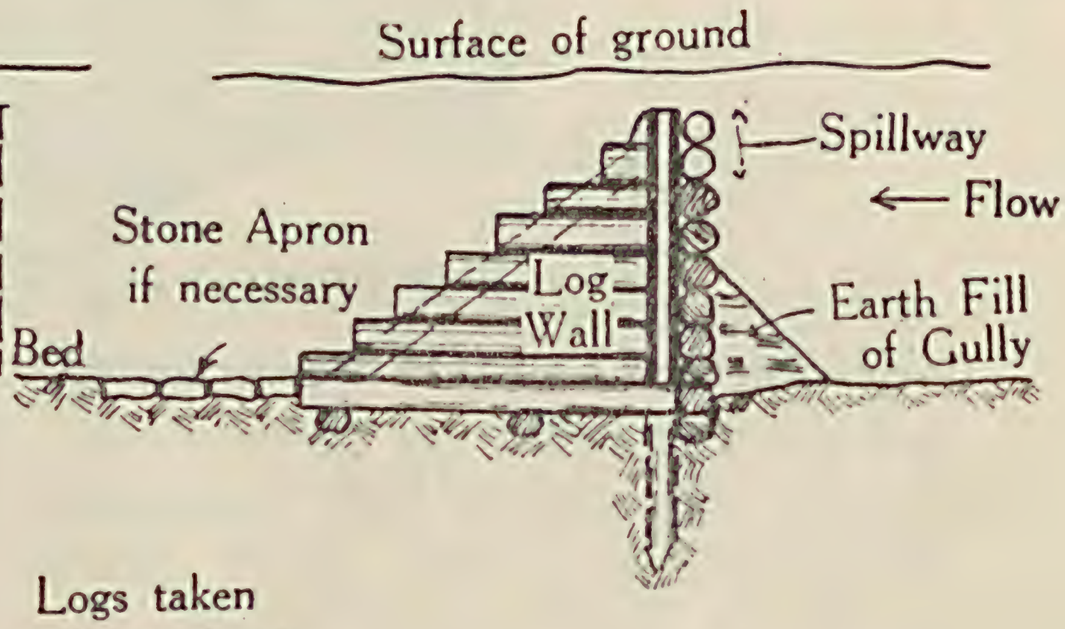
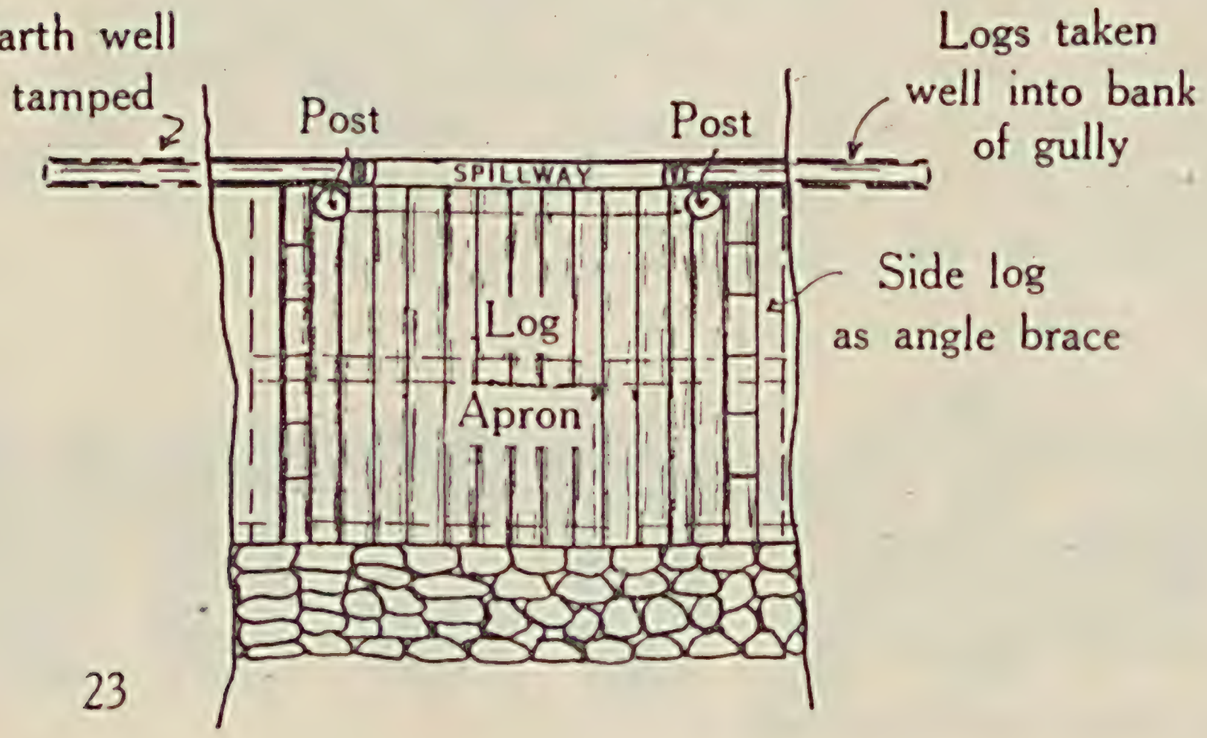



23

*Figs. 22 and 23.—Type of rock dam (top) and log dam (lower).*

side and their tops tied down on the opposite bank. This type is suitable only for small to medium gullies in sandy soil and with a hard bottom.

(2) Woven Wire Dams.

(*a*) **V Type.**—(Fig. 19.) This consists of a post set firmly in the centre of the gully, leaning downstream, to which is fixed a sheet of woven wire (this may be woven from fencing wire, or commercial mesh wire may be used; for small dams, pignetting, or even stout wire-netting is suitable). The ends of the wire are trenched into the banks, extending high enough above the top of the centre post to avoid endscour. The post should not extend more than say 18 inches above the gully bottom. The side of the wire sheet not stapled to the post should be turned upstream along the bed and banks of the gully, fastened down or trenched into the soil. This is suitable only for small V-shaped gullies.

(*b*) **Fixed-basket Type.**—(Fig. 20.) For wider gullies, a curved row of posts 2 to 3 feet apart should be set across the gully, higher at the ends, and wire mesh fastened to them, the surplus being turned upstream and fastened down. The wire should be lined with straw or dried grass, and then earth or sods. The tops of the posts are wired together, the wire being carried to anchorages well in the banks. An apron of brush or stones may have to be provided.

(*c*) **Suspended-net Type.**—(Fig. 21.) For the medium sized gullies, 3 ft. to 10 ft. deep. Stout posts are set on each bank, well back from the edge, and anchored to buried logs or "deadmen." These posts are connected by a cable of twisted wire or old wire rope, dipping in the middle. Strips of woven wire 8 to 15 feet long are attached to the cable, taken to the bottom of the gully, and then turned upstream along the bed or banks, each strip being wired to the next so as to form a continuous grid. The upstream end of this should be anchored to stakes or trenched in.

*Fig. 24.—Scour extending through former swamp on Sheep Pen Creek, near Caniambo. Subsoil is very friable, with high percentage of lime. Stormwater flow is now concentrated by training banks into the concrete spillway shown, where it loses most of its energy in a single drop.*

(3) Rock Dams (Fig. 22).

Dams may be built of loose rock or stones, if these are easily available. Flat-sided stones are best. A trench should be dug across the gully, and the dam built in it. The stones should be packed as close as possible. To give greater stability, the stones may be enclosed in a wire mesh cage, with other wires running through the pile to strengthen the cage; or the stones may be set in mortar or grouted. Suitable for small to medium gullies.

(4) Log Dams (Fig. 23).

These are suitable for a height of 3 to 4 feet. The logs should be trimmed to fit tightly together, and should be well secured. The dam should be

25

26

*Fig. 25.—Eaglehawk Creek, near Glengarry, Gippsland; originally, this flowed in a shallow swampy bed, till a drain about four feet wide was cut to define part of the creek. The creek is now about 40 feet by 30 feet, and still scouring. Fig. 26.—The sand and clay from the scour in Fig. 25 has spread over many acres of good land, greatly reducing productivity. In addition, heavy expense has been incurred in keeping railway and road bridges open.*

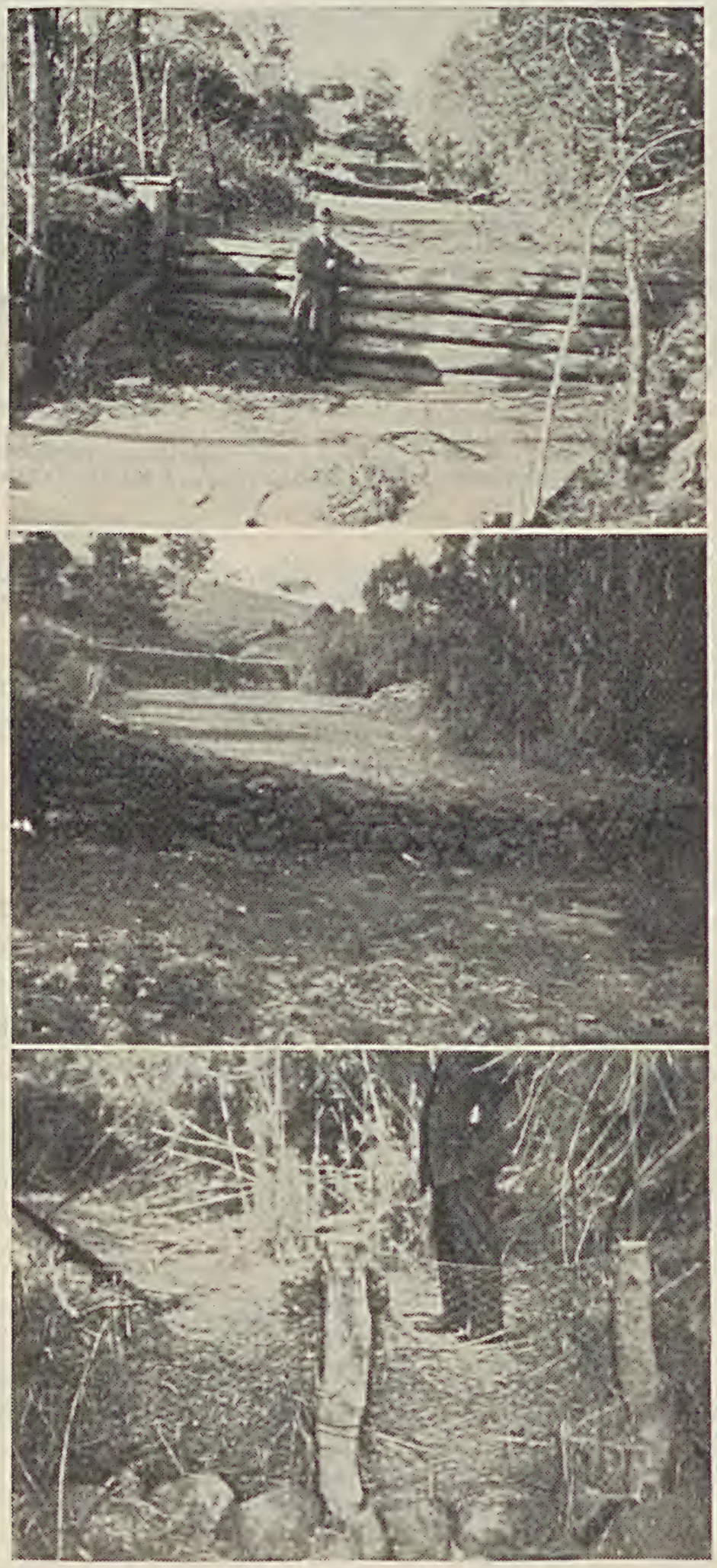


*Fig. 27.—(Examples of checkdams.) Three types of checkdam in a gully alongside Bacchus Marsh-Gisborne road. The log dam with concrete apron and stone wings has filled with silt to the top, effectively checking scour over several chains of gully. The stone dam with wire mesh cage has been constructed above the log dam to carry on the siltation. The third illustration shows how even a wire-netting fence will catch and hold silt.*

trenched into the gully at the bottom, and earth piled against the upstream face. An apron of logs, brush, or stone should be provided.

A good example of gullying and siltation and the effect of various types of checkdams—even wire fences—may be seen alongside the Bacchus Marsh-Gisborne road where it runs up the hill just above the bridge over the Lerderderg River, a few miles from the former town.

### *Prevention of Gullying.*

Erosion is like many other evils, in that prevention is cheaper than cure. Assuming, however, that it does commence, the earlier it is treated the better. A scour which on its first appearance can be checked by a few hours' work, may, if neglected, soon develop into a huge gulch which may cause serious loss of land and fencing, and which can only be checked at prohibitive cost. A landholder who values his land should thus always be on the watch for the commencement of erosion, and be prepared to check it as it appears. Having, moreover, noted where and how erosion has appeared on one portion of his property, he will be able to anticipate its appearance elsewhere, and take steps accordingly to prevent it. Particular notice should be taken of the nature of the soil and subsoil, as these vary enormously in erosion-resisting properties. What may be quite safe in one paddock may be highly dangerous in another half a mile away.

Rabbits are one of the most serious factors in causing erosion; partly because of their habit of destroying permanent grasses and young trees and partly because their burrows furnish starting places for scours in hillslopes and creekbanks. If the rabbits can be kept under, a double gain is experienced of increased productivity as well as decreased liability to scour.

When timbered hilly country is cleared, it must be expected that the rate of run-off from the slopes will be increased. This naturally increases the tendency to scour along drainage-lines and creeks, making it more necessary than ever that these should be protected and carefully watched. A strip should be left uncleared along each bank of every creek, even though there is no Crown land reserve, and even though the difficulty of vermin and weed control is increased thereby. Preferably, also, other drainage lines, even small depressions down the side of hillslopes, should be left uncleared or planted to shade trees; or, at the very least, planted with strong-rooting grasses and top-dressed.

All such drainage lines should be regularly inspected, even if water flows in them only a few times a year. Any small break or pothole should be filled and covered with tough sod, or brushwood should be rammed into it and staked down. Great caution should be exercised in undertaking any drainage works except in the flattest country. This especially applies to swampy areas, which have often a surprising amount of fall. Fig. 24 shows an example on the Sheep Pen Creek near the Broken River. Formerly this creek spread out hereabouts in a swampy section many chains

wide and two or three miles long. The fall through this swamp, however, was from 12 to 15 feet to the mile, and when a short drain was constructed to define the creek near the lower end of the swamp, a scour 6 to 8 feet deep developed which ran rapidly up through the friable soil of the swamp, branching out until many acres of the original surface had been lost. To check this, long wing banks had to be constructed to lead the water to the central concrete drop, shown in the illustration.

*Fig. 28.—Even a small road drain may get out of hand if it has a steep fall. This one, near Barnawartha, has taken most of the road, as well as part of a farmer's fence.*

Another marked example is that of the Eaglehawk Creek, near Glengarry, in Gippsland. Here a small drain, about 4 ft. by 3 ft., has enlarged to a canyon 40 ft. by 30 ft. The sand and clay subsoil from this scour have been washed down to cover many acres of good flats below, besides causing considerable expense for clearing road and railway bridges. (Figs. 25, 26.)

[*The diagrams reproduced with this article are "from Soil Erosion and Its Control," by Q. M. Ayres.*]

# *Christmas Mails for the United Kingdom and Europe*

The Deputy Director, Posts and Telegraphs desires to remind readers that to ensure delivery of parcels in the United Kingdom and Europe before Christmas, they must be posted in time to reach the General Post Office, Melbourne, before noon on Monday. 8th November, when the mail closes for despatch per the R.M.S. *Orion*.

The last mail for letters and packets for delivery before Christmas in the United Kingdom and Europe will be despatched per the R.M.S. *Moldavia*. Packet mails will close at Melbourne at 3 p.m. on the 18th November, 1937, and letter mails at 4 p.m. on that date.

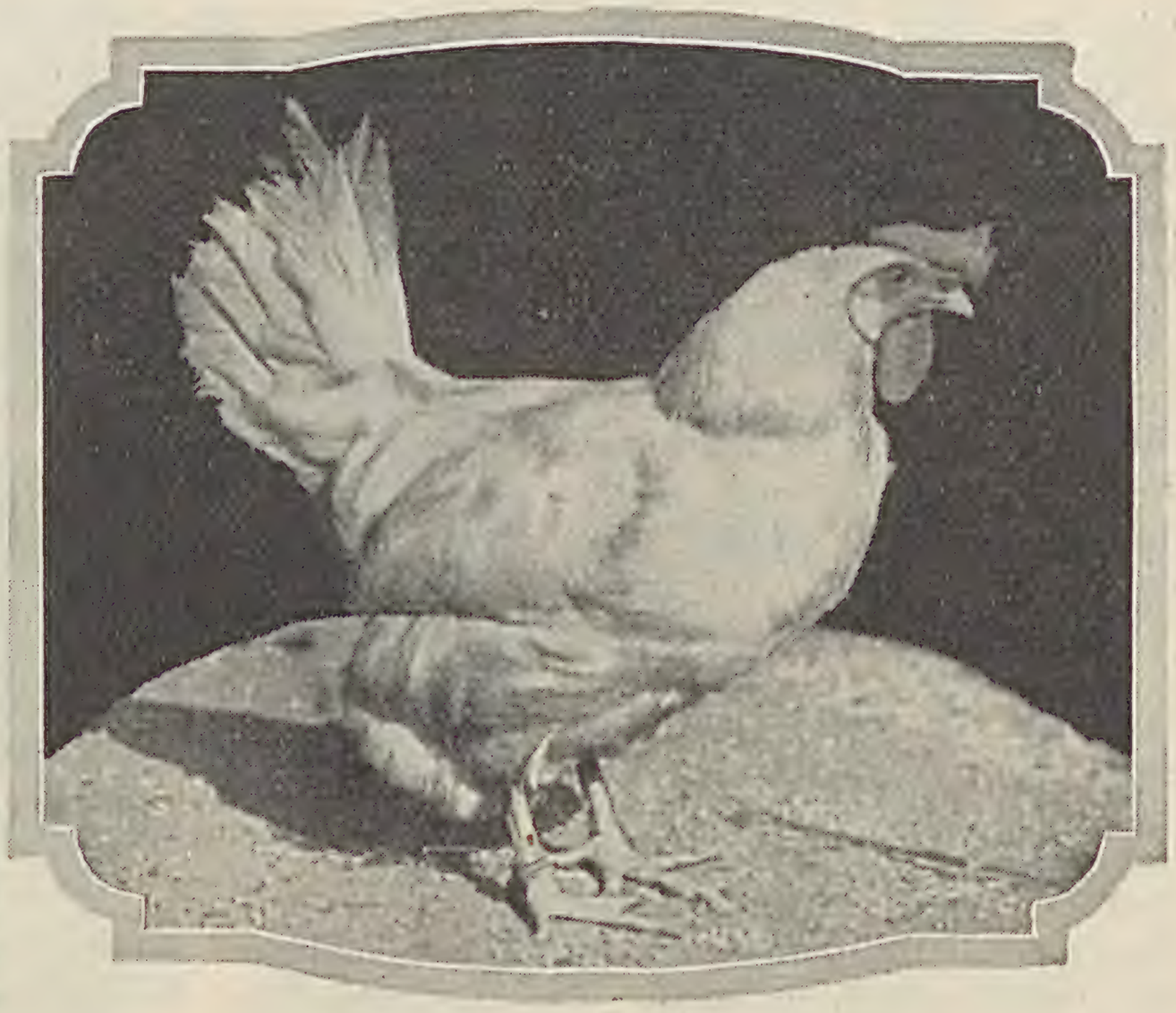
Although the *Moldavia* mails will reach London on the 18th December, 1937, the public is exhorted to post, so far as is practicable, Christmas mail for the United Kingdom and Europe in time for despatch per the R.M.S. *Orion*, as there will be a large accumulation of mail matter for delivery in the United Kingdom and Europe during the Christmas week. The packet mail for despatch by the *Orion* will close at the General Post Office, Spencer-street, Melbourne, at 3 p.m. on the 11th November, 1937, and the letter mail at 4 p.m. on that date.

As in the case of parcels, the senders of small packets are required to fill in and affix thereto a declaration form indicating the nature and value of the contents. Both parcels and small packets must be posted by being handed in over the counter of a post office.

# *Burnley Egg-Laying Competition*

## *Results of Winter Test*

*By H. F. Clinton, Poultry Expert.*



THE winter test, conducted in connexion with the Burnley Egg-laying Competition, covers only the first four months (122 days) of the competition which commenced on the 1st April. In this period certificates are awarded, in both tests for teams and individual birds, for the greatest number of first-grade eggs laid by light and heavy breeds respectively irrespective of class. Although the number of first-grade eggs laid by the leading teams of White Leghorns and Australorps was not quite equal to that of last year, generally, the number produced by the birds in other classes compared very favorably, and in some instances the scores were higher than those for the 1936–37 competition. During the first two months of the competition a first-grade egg must weigh not less than $1\frac{3}{4}$ oz., and thereafter during the remainder of the competition not less than 2 oz.

The first prize for teams of six birds, light breeds, was won by Mr. P. Lindsay's team of White Leghorns. During the period of the test these birds laid 442 first-grade eggs. This pen was also first in the class for wet mash. Messrs. P. C. and E. Thomson's team, whose birds also competed in the class for White Leghorns, wet mash, won second prize with 414 eggs. Mr. J. M. Sutherland's team was awarded third prize with a total of 403 eggs, and was also first in the class for White Leghorns, dry mash. In the heavy breeds section the first prize was awarded to a team of Australorps owned by Messrs. Aitken and Grenville. In the 122 days of the test these birds laid 480 first-grade eggs, the greatest number in the test for teams of six birds. Second prize was awarded to Mr. W. A. Shevill's team of Australorps which laid 460 eggs, and third prize was won by Mr. C. H. Harvey's team of Australorps with 451 eggs.

Certificates for the highest scores made by individual birds in the teams' test, light breeds, were won by Messrs. Northeast and Son's White Leghorn, first, with 101 first-grade eggs, while White Leghorns owned by Messrs. Aitken and Grenville and Mr. A. J. Hill won second and third prizes respectively, with 100 and 97 eggs respectively. In the heavy breeds section, Mrs. D. Mason's Australorp gained first prize with 104 first-grade eggs. An Australorp owned by Mr. W. B. Torrens ("Renwil") won second prize with 101 eggs, while equal third prizes were awarded to two birds entered by Messrs. Aitken and Grenville. Each of these birds laid 100 eggs.

In the section for single birds, light breeds, first prize was won by a White Leghorn owned by Mr. T. L. Eastaugh, with 104 first-grade eggs, and second and third prizes were both awarded to Mr. C. Garrard (Lawn-Garrard) for White Leghorns which laid 102 and 100 eggs respectively. All these White Leghorns competed in the class for wet mash. In the heavy breeds section for single birds, first prize was awarded to Mr. T. L. Eastaugh's Australorp, which laid 109 first-grade eggs, the highest score recorded in the test for single birds. Second and third prizes were won with Australorps owned by Mr. W. Cullen and Mr. C. E. Graham, which laid 107 and 105 eggs respectively.

A summary of the leading scores is shown on the next page.

## SECTION A.—TEAMS OF SIX BIRDS, TRAP-NESTED.

| Pen No. | Name and Address. | First Grade Eggs. |
|---|---|---|
| | **Class 1.—White Leghorns—Wet Mash.** | |
| | First Prize—Champion Certificate (Light Breeds). | |
| 9 | P. Lindsay, Murray-avenue, North Wonthaggi | 442 |
| | Second Prize—Government Certificate (Light Breeds). | |
| 21 | P. C. and E. Thomson, 142 Fyans-street, South Geelong | 414 |
| 7 | H. I. Jolly, Nelson-road, Trafalgar .. | 402 |
| | **Class 2.—White Leghorns—Dry Mash.** | |
| | Third Prize—Government Certificate (Light Breeds). | |
| 34 | J. M. Sutherland, Fulton-road, Box Hill .. | 403 |
| 36 | Sorrento Farm, Campbell-road, Sorrento | 380 |
| 32 | S. N. Lloyd, "Cranhaven," Box 10, Frankston | 347 |
| | **Class 3.—All Light Breeds other than White Leghorns—Wet Mash.** | |
| 46 | Sorrento Farm, Campbell-road, Sorrento (Black Leghorn) | 309 |
| 45 | Carlella P. Farm (J. W. Stoneman), Campbell-street, Briar Hill (Brown Leghorn) | 243 |
| 44 | D. Granter, 163 Martin-street, Gardenvale, S.4. (Brown Leghorn) | 187 |
| | **Class 4.—Australorps—Wet Mash.** | |
| | First Prize—Champion Certificate (Heavy Breeds.) | |
| 60 | Aitken and Grenville, Silver-street, Cheltenham, S.22 | 480 |
| | Second Prize—Government Certificate (Heavy Breeds). | |
| 68 | W. A. Shevill, 35 Bourke-street, Mentone, S.11 | 460 |
| | Third Prize—Government Certificate (Heavy Breeds). | |
| 64 | C. H. Harvey, Pakenham South .. | 451 |
| | **Class 5.—All Heavy Breeds other than Australorps—Wet Mash.** | |
| 47 | S. N. Lloyd, "Cranhaven," Box 10, Frankston (Rhode Island Reds) | 376 |
| 48 | W. Tedstone, Whitehorse-road, Balwyn, E.8 (Rhode Island Reds) | 192 |

## SECTION B.—INDIVIDUAL BIRDS, SINGLE TEST.

| Pen No. | Name and Address. | First Grade Eggs. |
|---|---|---|
| | **Class 1.—White Leghorns—Wet Mash.** | |
| | First Prize—Champion Certificate (Light Breeds). | |
| 18 | T. L. Eastaugh, Point Nepean-road, Highett, S.21 | 104 |

**Section B.—continued.**

| Pen No. | Name and Address. | First Grade Eggs. |
|---|---|---|
| | **Class 1.—continued.** | |
| | Second Prize—Government Certificate (Light Breeds). | |
| 20 | Lawn-Garrard (C. Garrard), 48 Cooper-street, Preston, N.18 | 102 |
| | Third Prize—Government Certificate (Light Breeds). | |
| 19 | Lawn-Garrard (C. Garrard), 48 Cooper-street, Preston, N.18 | 100 |
| | **Class 2.—White Leghorns—Dry Mash.** | |
| 224 | G. E. Thomas, "Rosanna," Chesterville-road, Cheltenham, S.22 | 94 |
| 219 | "Caithness" (M. G. Skinner), 75 Vincent-street, Sandringham, S.8 | 93 |
| 213 | T. A. Pettigrove, 159 Hawdon-street, Heidelberg, N.22 | 92 |
| | **Class 3.—All Light Breeds other than White Leghorns—Wet Mash.** | |
| 88 | Sorrento Farm, Campbell-road, Sorrento (Black Leghorn) | 72 |
| 90 | Roy Hull, Cosgrove South, via Shepparton (Andalusian) | 55 |
| 89 | Roy Hull, Cosgrove South, via Shepparton (Andalusian) | 51 |
| | **Class 4.—Australorps—Wet Mash.** | |
| | First Prize, Champion Certificate (Heavy Breeds). | |
| 110 | T. L. Eastaugh, Point Nepean-road, Highett, S.21 | 109 |
| | Second Prize, Government Certificate (Heavy Breeds). | |
| 106 | W. Cullen, Werribee Poultry Farm, Werribee | 107 |
| | Third Prize, Government Certificate (Heavy Breeds). | |
| 114 | C. E. Graham, Portarlington .. .. | 105 |
| | **Class 5.—Rhode Islands—Wet Mash.** | |
| 182 | J. Chatts, Miyea Poultry Farm, White-street Beaumaris, S.10 (Rhode Island Red) | 90 |
| 191 | W. Drinkwater, 6 Kennedy-street, Fairfield, Park, N.20 (Rhode Island Red) | 88 |
| 189 | F. J. Meyer, "Kiriwina," Camp-street, Daylesford (Rhode Island Red) | 84 |
| | **Class 5.—All Heavy Breeds other than Australorps and Rhode Island—Wet Mash.** | |
| 166 | C. J. Coulson, 7 Rose-street, Sandringham (Light Sussex) | 90 |
| 165 | C. J. Coulson, 7 Rose-street, Sandringham (Light Sussex) | 71 |
| 168 | H. R. Cropley, Boronia-road, Bayswater (Light Sussex) | 69 |

**SECTION A.—TEAMS OF SIX BIRDS—TRAP-NESTED.**

| Pen No. | Name and Address. | Bird No. | First Grade Eggs. |
|---|---|---|---|
| | **Individual Birds (Light Breeds).** | | |
| | First Prize, Champion Certificate. | | |
| 15 | Northeast and Son, 40 Elster-avenue, Gardenvale, S.4 (White Leghorn) | 87 | 101 |
| | Second Prize, Government Certificate. | | |
| 1 | Aitken and Grenville, Silver-street, Cheltenham, S.22 (White Leghorn) | 5 | 100 |
| | Third Prize, Government Certificate. | | |
| 40 | A. J. Hill, Sunraysia Poultry Farm, Greensborough (White Leghorn) | 235 | 97 |
| | **Individual Birds (Heavy Breeds).** | | |
| | First Prize, Champion Certificate. | | |
| 67 | Mrs. D. Mason, Mount Evelyn-road, Lilydale (Australorp) | 400 | 104 |

**SECTION A.—TEAMS OF SIX BIRDS—TRAP-NESTED.**—continued.

| Pen No. | Name and Address. | Bird No. | First Grade Eggs. |
|---|---|---|---|
| | **Individual Birds (Heavy Breeds).**—continued. | | |
| | Second Prize, Government Certificate. | | |
| 70 | "Renwil," (W. B. Torrens), 171 Cape-street, Heidelberg, N.22 (Australorp) | 420 | 101 |
| | Equal Third Prize, Government Certificate. | | |
| 60 | Aitken and Grenville, Silver-street, Cheltenham, S.22 (Australorp) | 355 | 100 |
| | Equal Third Prize, Government Certificate. | | |
| 60 | Aitken and Grenville, Silver-street, Cheltenham, S.22 (Australorp) | 359 | 100 |

# *Book Review*

***"A Practical Course in Agricultural Chemistry"—By F. Knowles and J. E. Watkin.***

THE authors have attained a considerable measure of success in their object of producing a practical text-book suitable for the requirements of students in degree and diploma courses in Agriculture, Horticulture, Dairying, and Poultry Husbandry. The writers have had many years' experience in lecturing and research at the East Anglian Institute of Agriculture, Chelmsford.

The book is well-balanced in its treatment of the chief phases of agricultural chemistry: individual chapters are concerned with soils, fertilizers and manures, plant and animal bio-chemistry, feeding stuffs, dairy products, waters, and insecticides and fungicides. There is an index, and an appendix on the composition of certain chemical reagents mentioned in the text.

Sufficient annotation is given to place the analytical procedures in their correct perspective with respect to practical agriculture and industry. Adequate descriptions are given of a wide range of recent chemical and physical tests, both quantitative and qualitative, which have proved sound and useful.

Publication is by Macmillan and Co., London, and the book is produced well, having 188 pages, set up in clear type and with 21 text figures. The English price is 10s.

F.P.

# Poultry Feeding Tests

## Results at Werribee

*W. O. Pederick and A. G. Clark.*

EXTENDING over a period of twelve months from the 1st April, 1936, to the 31st March, 1937, several poultry feeding tests were conducted at the State Research Farm, Werribee. For the purpose, 500 pullets were used, consisting of seven pens of Australorps with 50 birds in each pen, and three pens of White Leghorns with 50 birds in each. All birds were kept confined, i.e., there was no outside run, although succulent green feed was supplied daily and shell-grit was always available.

The accompanying tables give particulars of the food consumed, the eggs laid, and their value, the profit over food cost, the weight of the birds and the mortality in each pen. The cost of food was arrived at by taking the wholesale prices published in the press weekly, and all eggs laid were valued at the wholesale prices for standard grade eggs. No deductions have been made for marketing charges, &c. Those birds that died were replaced.

To enable comparisons to be made these tests have been divided into three sections.

*Section* 1.—All birds in Pens Nos. 1 to 4 (Australorps) were fed a dry mash mixture in the proportion of 30 lb. bran and 60 lb. pollard. Added to the mash were varying quantities of protein concentrates of animal origin (meat meal, dried buttermilk and dried whey). The mash was always available and mixed grain in the proportion of wheat, three parts (by weight), oats, maize and barley, one part each, was fed in the litter at night.

The greatest number of eggs was laid by birds in Pen No. 4, which received, in addition to the dry mash, 10 per cent. of dried buttermilk. The highest profit over food cost was also shown by these birds. Pen No. 2, 10 per cent. meat meal; Pen No. 3, 10 per cent. dried buttermilk and 3 per cent. dried whey; and Pen No. 1, 10 per cent. meat meal and 3 per cent. dried whey followed in that order.

### Summary of Results.—Section 1.

| Pen. | Dry Mash with Mixed Grain fed in Litter. | Average per Bird. | | | | |
|---|---|---|---|---|---|---|
| | | Food Consumed. | Cost of Food. | Eggs Laid. | Value of Eggs. | Profit over Cost of Food. |
| | | lb. | *s. d.* | | *s. d.* | *s. d.* |
| 1 | 10 per cent. meat-meal and 3 per cent. dried whey | 82·7 | 6 2¼ | 164·9 | 17 1¼ | 10 11 |
| 2 | 10 per cent. meat-meal .. .. | 85·4 | 6 2¾ | 184·1 | 18 9½ | 12 6¾ |
| 3 | 10 per cent. butter-milk and 3 per cent. dried whey | 89·5 | 7 0 | 183·9 | 18 10 | 11 10 |
| 4 | 10 per cent. dried buttermilk .. | 92·6 | 6 8¾ | 192·6 | 19 8 | 12 11¼ |

It is interesting to note that the highest production ever obtained in the feeding tests at Werribee was in 1924–25, when a pen of 60 White Leghorn pullets, fed on a similar ration to the one used in Pen No. 4, i.e., 10 per cent. dried buttermilk in the dry mash, laid an average of 211 eggs per bird in twelve months.

*Section* 2 (Australorps).—The birds in this experiment were fed on the free choice system, i.e., the different foods were available at all times in separate hoppers. The same type of animal protein concentrate as that used in Section 1 was used in Section 2.

### Average Weight of Birds.

Showing the average weight of the birds in each pen at different periods, also the number of deaths recorded in each pen during the test.

| Pen No. | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. |
|---|---|---|---|---|---|---|---|---|---|---|
| | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. |
| April, 1936 .. .. .. .. | 5·4 | 5·4 | 5·4 | 5·56 | 5·94 | 6·12 | 5·89 | 4·26 | 4·4 | 4·48 |
| October, 1936 .. .. .. .. | 5·92 | 5·7 | 5·9 | 6·0 | 6·08 | 6·4 | 6·4 | 4·0 | 4·54 | 4·44 |
| March, 1937 .. .. .. .. | 5·96 | 5·7 | 5·8 | 5·9 | 6·14 | 6·4 | 6·35 | 4·2 | 4·6 | 4·7 |
| Number of deaths recorded in each pen .. | 3 | 4 | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 2 |

SHOWING AVERAGE MONTHLY PRODUCTION PER BIRD, 1922–37.

| Month. | Average for 14 years 1922–36. | | Average for 1 year 1936–37. | | Average to date—15 years 1922–37. | |
|---|---|---|---|---|---|---|
| | No. of Birds. | Average per Bird. | No. of Birds. | Average per Bird. | No. of Birds. | Average per Bird. |
| | | Eggs. | | Eggs. | | Eggs. |
| April .. .. .. | 4,176 | 11·3 | 500 | 15·6 | 4,676 | 11·8 |
| May .. .. .. | 5,216 | 11·4 | 500 | 14·2 | 5,716 | 11·6 |
| June .. .. .. | 5,216 | 10·7 | 500 | 14·6 | 5,716 | 11·1 |
| July .. .. .. | 5,216 | 11·9 | 500 | 15·5 | 5,716 | 12·2 |
| August .. .. .. | 5,216 | 16·3 | 500 | 17·5 | 5,716 | 16·4 |
| September .. .. .. | 5,216 | 19·1 | 500 | 19·2 | 5,716 | 19·1 |
| October .. .. .. | 5,216 | 19·7 | 500 | 19·6 | 5,716 | 19·7 |
| November .. .. .. | 5,216 | 17·7 | 500 | 17·3 | 5,716 | 17·7 |
| December .. .. .. | 5,216 | 16·0 | 500 | 15·8 | 5,716 | 15.9 |
| January .. .. .. | 5,216 | 15·0 | 500 | 14·6 | 5,716 | 15·0 |
| February .. .. .. | 5,216 | 12·4 | 500 | 12·1 | 5,716 | 12·4 |
| March .. .. .. | 2,816 | 10·4 | 500 | 12·0 | 3,316 | 10·6 |
| Average for year .. | .. | 171·9 | .. | 188·0 | .. | 173·5 |

The results of this test were inconsistent with those obtained in Section 1. The fowls in Pen No. 5, which received meat meal only as a concentrate, laid the greatest number of eggs and showed the highest profit over food cost. Pen No. 7—meat meal and dried whey—was second with almost as many eggs, and Pen No. 6—dried buttermilk—was last with 14 eggs per bird less than the other two pens.

The total amount of food consumed in each of the three pens was practically the same, but the quantity of bran and pollard varied considerably; 644 lb. being eaten by the birds in Pen No. 5, 251 lb. in Pen No. 6, and 219 lb. in Pen No. 7. The amount of the concentrates eaten also varied; 150 lb. of meat meal in Pen No. 5, 284 lb. of dried buttermilk in Pen No. 6, and 430 lb. of meat meal and dried whey in Pen No. 7.

SUMMARY OF RESULTS.—SECTION 2.

| Pen. | Free Choice Meals and Grains. | Average per Bird. Food Consumed. | Cost of Food. | Eggs Laid. | Value of Eggs. | Profit over Cost of Food. |
|---|---|---|---|---|---|---|
| | | lb. | s. d. | | s. d. | s. d. |
| 5 | Meatmeal .. | 84·6 | 6 5¾ | 196·8 | 20 3¾ | 13 10 |
| 6 | Dried buttermilk | 83·3 | 6 11¾ | 182·7 | 19 0¼ | 12 0¼ |
| 7 | Meatmeal and dried whey .. | 84·3 | 6 11½ | 196·0 | 20 1¾ | 13 2¼ |

*Section* 3.—This consisted of a wet mash versus soaked grain test conducted with three pens (8 to 10) of White Leghorns.

In Pen No. 8, the ordinary wet mash made up in the proportions of bran 30 lb., pollard 60 lb., and meat meal 10 lb., was fed in the morning, and mixed grain, consisting of wheat three parts (by weight), oats, maize and barley, one part each, in the litter at night. In Pen No. 9, the mixed grain (in the same proportion as that in Pen No. 8), was soaked in water for 24 hours and fed in troughs twice a day, morning and evening. In addition, meat meal and dried whey were available all the time in separate hoppers. In Pen No. 10, the feeding was the same as that in Pen No. 9, with the exception that dried buttermilk was supplied instead of dried whey.

SUMMARY OF RESULTS.—SECTION 3.

| Pen. | — | Average per Bird. Food Consumed. | Cost of Food. | Eggs Laid. | Value of Eggs. | Profit over Cost of Food. |
|---|---|---|---|---|---|---|
| | | lb. | s. d. | | s. d. | s. d. |
| 8 | Wet mash .. | 73·0 | 5 4¾ | 192·4 | 19 7¾ | 14 3 |
| 9 | Soaked grain .. | 91·1 | 7 10¾ | 185·3 | 18 11 | 11 0¼ |
| 10 | Soaked grain .. | 88·6 | 7 10 | 201·2 | 20 6¼ | 12 8¼ |

From the results shown in the accompanying table, it will be seen that while one of the pens receiving soaked grain (No. 10) produced more eggs than the wet mash pen (No. 8), the other (No. 7) produced less. However, in Pen No. 8 the profit over food cost was higher, and the amount of food consumed lower, than was the case with either of the soaked grain pens. The large amount of meat meal, dried buttermilk and

dried whey consumed in the latter pens is very largely responsible for this increase in the cost of food.

In Pen No. 9 the birds ate 905 lb. of meat meal and dried whey, which is approximately 20 per cent. of the total ration, and in Pen No. 10 they ate 781 lb. of the same foodstuffs, or approximately 17 per cent. of the total, whereas in the wet-mash pen (No. 8) the amount of meat meal supplied was 128 lb., which is 10 per cent. of the mash, but 3½ per cent. only of the total ration.

The usual method adopted when feeding soaked grain is to add 10 lb. of meat meal every 100 lb. of grain (dry), but, in these tests, when the meat meal, &c., were available to the birds all the time (separately in hoppers), nearly double that amount was taken. However, notwithstanding that fact, the birds maintained good health and condition and laid satisfactorily.

Several other systems of soaked grain feeding are being tested at Werribee again this year, and these results will be published at a later date.

## *Test No. 17.*

WERRIBEE FEED TESTS—1ST APRIL, 1936, TO 31ST MARCH, 1937.

| Pen No. (Fifty Birds per Pen.) | Pen. | Food. Bran. | Pollard. | Meat Meal. | Dried Buttermilk. | Dried Whey. | Wheat. | Oats. | Maize. | Barley. | Total Feed. | Cost of Feed. | Eggs Laid. | Value of Eggs. | Profit Over Cost of Food. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. | £ s. d. | | £ s. d. | £ s. d. |
| 1 | Australorps—Dry mash; grain in litter .. | 513 | 1,026 | 171 | .. | 51 | 1,187 | 395 | 395 | 395 | 4,133 | 15 9 3 | 8,244 | 42 15 8 | 27 6 5 |
| | **Average .. ..** | .. | .. | .. | .. | .. | .. | .. | .. | .. | **82·7** | **0 6 2¼** | **164·9** | **0 17 1¼** | **0 10 11** |
| 2 | Australorps—Dry mash; grain in litter .. | 569 | 1,138 | 189 | .. | .. | 1,187 | 395 | 395 | 395 | 4,268 | 15 11 10 | 9,203 | 46 19 5 | 31 7 7 |
| | **Average .. ..** | .. | .. | .. | .. | .. | .. | .. | .. | .. | **85·4** | **0 6 2¾** | **184·1** | **0 18 9½** | **0 12 6¾** |
| 3 | Australorps—Dry mash; grain in litter .. | 613 | 1,226 | .. | 204 | 62 | 1,187 | 395 | 395 | 395 | 4,477 | 17 9 7 | 9,193 | 47 1 9 | 29 12 2 |
| | **Average .. ..** | .. | .. | .. | .. | .. | .. | .. | .. | .. | **89·5** | **0 7 0** | **183·9** | **0 18 10** | **0 11 10** |
| 4 | Australorps—Dry mash; grain in litter .. | 677 | 1,354 | .. | 226 | .. | 1,187 | 395 | 395 | 395 | 4,629 | 16 16 5 | 9,628 | 49 3 2 | 32 6 9 |
| | **Average .. ..** | .. | .. | .. | .. | .. | .. | .. | .. | .. | **92·6** | **0 6 8¾** | **192·6** | **0 19 8** | **0 12 11¼** |
| 5 | Australorps—Free choice | 424 | 220 | 150 | .. | .. | 1,848 | 720 | 705 | 165 | 4,232 | 16 4 5 | 9,842 | 50 15 7 | 34 11 2 |
| | **Average .. ..** | .. | .. | .. | .. | .. | .. | .. | .. | .. | **84·6** | **0 6 5¾** | **196·8** | **1 0 3¾** | **0 13 10** |
| 6 | Australorps—Free choice | 120 | 131 | .. | 284 | .. | 1,657 | 822 | 828 | 325 | 4,167 | 17 9 1 | 9,136 | 47 10 11 | 30 1 10 |
| | **Average .. ..** | .. | .. | .. | .. | .. | .. | .. | .. | .. | **83·3** | **0 6 11¾** | **182·7** | **0 19 0¼** | **0 12 0¼** |
| 7 | Australorps—Free choice | 89 | 130 | 270 | .. | 160 | 1,764 | 864 | 687 | 252 | 4,216 | 17 8 0 | 9,801 | 50 6 11 | 32 18 11 |
| | **Average .. ..** | .. | .. | .. | .. | .. | .. | .. | .. | .. | **84·3** | **0 6 11½** | **196·0** | **1 0 1¾** | **0 13 2¼** |
| 8 | White Leghorns—Wet mash; grain in litter | 383 | 767 | 128 | .. | .. | 1,187 | 395 | 395 | 395 | 3,650 | 13 10 0 | 9,619 | 49 2 2 | 35 12 2 |
| | **Average .. ..** | .. | .. | .. | .. | .. | .. | .. | .. | .. | **73·0** | **0 5 4¾** | **192·4** | **0 19 7¾** | **0 14 3** |
| 9 | White Leghorn—Soaked grain, free choice, meat-meal and dried whey .. | .. | .. | 691 | .. | 214 | 1,826 | 608 | 608 | 608 | 4,555 | 19 14 10 | 9,264 | 47 6 0 | 27 11 2 |
| | **Average .. ..** | .. | .. | .. | .. | .. | .. | .. | .. | .. | **91·1** | **0 7 10¾** | **185·3** | **0 18 11** | **0 11 0¼** |
| 10 | White Leghorn—Soaked grain, free choice, meat-meal and dried butter-milk .. .. | .. | .. | 397 | 384 | .. | 1,826 | 608 | 608 | 608 | 4,431 | 19 11 2 | 10,058 | 51 6 0 | 31 14 10 |
| | **Average .. ..** | .. | .. | .. | .. | .. | .. | .. | .. | .. | **88·6** | **0 7 10** | **201·2** | **1 0 6¼** | **0 12 8¼** |
| | Total—500 birds .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 42,758 | 169 4 7 | 93,988 | 482 7 7 | 313 3 0 |
| | **Average .. ..** | .. | .. | .. | .. | .. | .. | .. | .. | .. | **85·5** | **0 6 9¼** | **188·0** | **0 19 3½** | **0 12 6¼** |

NOTES.—Average price of eggs, 1s. 2·7d. per doz. Food cost per dozen eggs 5·2 pence. Food consumed per egg laid, 7·3 oz. Food consumed per bird per day 3·7 oz. Cost of food per bird per week, 1·6 pence.

# *Butter Production and Export.*

The following table shows :—

(*a*) Factory production of butter and cheese in Victoria for the period July, 1936, to June, 1937, compared with the corresponding period of 1935–36 ; and

(*b*) Quantities and percentages of various grades of bulk butter examined for export in Victoria from 1st July, 1937, to 28th August, 1937, in comparison with the corresponding period of 1936.

FACTORY PRODUCTION OF BUTTER AND CHEESE IN VICTORIA (QUANTITIES IN TONS).

| Month. | Butter. | | Cheese. | |
|---|---|---|---|---|
| | 1936–37. | 1935–36. | 1936–37. | 1935–36. |
| July .. .. .. .. .. .. | 2,430 | 3,039 | 242 | 285 |
| August .. .. .. .. .. | 3,556 | 4,365 | 372 | 367 |
| September .. .. .. .. .. | 6,727 | 6,159 | 527 | 504 |
| October .. .. .. .. .. | 8,635 | 9,309 | 748 | 689 |
| November .. .. .. .. .. | 9,142 | 10,136 | 819 | 681 |
| December .. .. .. .. .. | 8,847 | 8,476 | 709 | 579 |
| January .. .. .. .. .. | 7,866 | 6,670 | 632 | 483 |
| February .. .. .. .. .. | 5,874 | 4,613 | 466 | 334 |
| March .. .. .. .. .. .. | 5,080 | 3,589 | 423 | 263 |
| April .. .. .. .. .. .. | 3,712 | 2,853 | 350 | 226 |
| May .. .. .. .. .. .. | 2,808 | 2,406 | 297 | 204 |
| June .. .. .. .. .. .. | 2,153 | 2,148 | 240 | 208 |
| Totals, 12 months .. .. .. | 66,830 | 63,763 | 5,825 | 4,823 |

BULK BUTTER EXAMINED FOR EXPORT IN VICTORIA (QUANTITIES IN TONS).

| Period. | 1937–38. | | | | | Period. | 1936–37. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | How Graded— | | | | Total. | | How Graded— | | | | Total. |
| | Ch. | 1st. | 2nd. | Pty. | | | Ch. | 1st. | 2nd. | Pty. | |
| 1st July to 24th July .. | .. | 7 | 9 | 2 | 18 | 1st July to 25th July | 30 | 9 | 15 | 2 | 56 |
| 25th July to 28th August .. .. | 272 | 84 | 51 | 2 | 409 | 26th July to 29th August .. | 757 | 305 | 91 | 15 | 1,168 |
| Totals 1st July to 28th August .. | 272 | 91 | 60 | 4 | 427 | Totals 1st July to 29th August .. | 787 | 314 | 106 | 17 | 1,224 |
| Percentages .. | 63·7 | 21·3 | 14·0 | 1·0 | .. | Percentages .. | 64·3 | 25·6 | 8·7 | 1·4 | .. |

# *Manurial Trials on Potatoes*

## *Results for 1936-37*

*By J. T. Ramsay, Potato Expert.*

THE results obtained from the potato manurial trials, which are conducted throughout the potato-growing districts of the State, varied greatly during the past season. Some areas were favoured with satisfactory rains at the right time, while others did not receive any at the critical period, i.e., flowering.

In spite of these conditions however, the increases due to manurial treatments were quite marked and substantially supported the findings of other years.

### *TRENTHAM.*

Owing to a spell of dry weather at flowering time, the yields at Trentham were considerably below average. There was, however, a striking increase in favour of the mixture, superphosphate and sulphate of ammonia. While the greatest increase in yield was obtained with the "3 and 2" dressing, the most economical one proved to be "3 and 1," which showed a 78 per cent. better yield than "no manure."

Although, on the volcanic areas, the average increase from the "3 and 2" dressing has been greater than the "3 and 1" over a five-year

TABLE I.—POTATO MANURIAL TESTS, TRENTHAM EAST, 1936–37.

| Manure per Acre. | Weight Marketable Tubers. | Increase due to Manure. | Percentage Increase. |
|---|---|---|---|
| | T. C. | T. C. | % |
| Super., 2 cwt. .. | 3 1 | 0 6 | **11** |
| Super., 3 cwt. .. | 3 8 | 0 13 | **24** |
| Super., 4 cwt. .. | 3 13 | 0 18 | **33** |
| No manure .. .. | 2 15 | .. | .. |
| Super., 3 cwt. + sulp. amm., 1 cwt. .. | 4 18 | 2 3 | **78** |
| Super., 3 cwt. + sulp. amm., 2 cwt. .. | 5 8 | 2 13 | **96** |

TABLE II.—AVERAGE RESULTS, TRENTHAM EAST, FOR TEN YEARS, 1927–28 TO 1936–37.

| Manure per Acre. | Average Yield. | Percentage Increase. |
|---|---|---|
| | T. C. | % |
| Super., 2 cwt. .. .. .. | 4 10 | **53** |
| Super., 3 cwt. .. .. .. | 5 4 | **76** |
| Super., 4 cwt. .. .. .. | 5 2 | **73** |
| No manure .. .. .. | 2 19 | .. |
| Super., 3 cwt. + sulp. amm., 1 cwt. | 6 0 | **103** |
| Super., 3 cwt. + sulp. amm., 2 cwt. | 6 5 | **119*** |

* 5 years only.

***Potato trials at Trentham showing increased vigour due to artificial fertilizer. Left, no manure, right, super and ammonia, "3 and 1."***

period, the cost of the extra hundredweight of ammonium sulphate would be justified only in seasons when potatoes were a reasonably fair price.

Details of the results for the season 1936–37 and the average yield obtained for the period of years over which the tests have been conducted, are shown in Tables I. and II. The weights of small potatoes have not been taken into account in any of these trials, the figures given being for marketable tubers only.

It will be seen from Table II. that the increases due to super. and ammonia are substantial, the yields being more than twice that of the "no manure."

## *WHEATSHEAF.*

The plots at Wheatsheaf were harvested on 1st June and, owing to a dry spell during March and April, the yields obtained were much lighter than usual. The variety planted was Snowflake and the resultant crop was rather rough in shape due to second growth.

The fertilizer showing to the greatest advantage at Wheatsheaf during the last nine years is the "3 and 1" mixture of super. and ammonia. During this period it has been responsible for an average increase of 63 per cent. The soil at this centre does not appear to respond to the heavier dressing of ammonium sulphate, and super. alone is not sufficient.

The returns obtained last season and the average results for the past nine years are shown in Tables III. and IV.

## *WARRAGUL.*

High tonnages were expected from the Warragul plots this season, but the advent of blight caused serious reduction in yield, and, to a certain extent, interfered with results. The disease was scattered throughout the paddock and difficulty was experienced in taking a truly representative weighing. Plots were affected to a varying degree, it being estimated that yields were reduced anything from 10 to 40 per cent.

The growth on the plot was so dense that it was possible to give only one combined cultivation and partial hilling in the early part of the season.

TABLE V.—POTATO MANURIAL TRIALS, WARRAGUL, 1936–37.

| Manure per Acre. | Weight Marketable Tubers. | Increase due to Manure. | Percentage Increase. |
|---|---|---|---|
| | T. C. | T. C. | % |
| Super., 4½ cwt. .. | 7 7 | 2 10 | **51** |
| Super., 6 cwt. .. | 7 18 | 3 1 | **63** |
| Super., 6 cwt. + pot. sulp., 1 cwt. .. | 7 13 | 2 16 | **58** |
| No manure .. .. | 4 17 | .. | .. |
| Super., 6 cwt. + pot. sulp., 2 cwt. .. | 9 10 | 4 13 | **95** |
| Super., 6 cwt. + sulp. amm., 1 cwt. .. | 8 19 | 4 2 | **84** |
| Super., 6 cwt. + pot. sulp., 1 cwt. + amm. sulp., 1 cwt. .. | 8 9 | 3 12 | **74** |

TABLE III.—POTATO MANURIAL TESTS, WHEATSHEAF, 1936–37.

| Manure per Acre. | Weight Marketable Tubers. | Increase due to Manure. | Percentage Increase. |
|---|---|---|---|
| | T. C. | T. C. | % |
| Super., 2 cwt. .. | 5 10 | 0 5 | **5** |
| Super., 3 cwt. .. | 5 15 | 0 10 | **10** |
| Super., 4 cwt. .. | 5 15 | 0 10 | **10** |
| No manure .. .. | 5 5 | .. | .. |
| Super., 3 cwt. + sulp. amm., 1 cwt. .. | 7 18 | 2 13 | **50** |
| Super., 3 cwt. + sulp. amm., 2 cwt. .. | 7 8 | 2 3 | **41** |

TABLE IV.—AVERAGE RESULTS, WHEATSHEAF, FOR NINE YEARS, 1928–29 TO 1936–37.

| Manure per Acre. | Average Yield. | Percentage Increase. |
|---|---|---|
| | T. C. | % |
| Super., 2 cwt. .. .. .. | 4 15 | **27** |
| Super., 3 cwt. .. .. .. | 5 0 | **33** |
| Super., 4 cwt. .. .. .. | 5 5 | **40** |
| No manure .. .. .. | 3 15 | .. |
| Super., 3 cwt. + sulp. amm., 1 cwt. | 6 2 | **63** |
| Super., 3 cwt. + sulp. amm., 2 cwt. | 6 15 | **55*** |

* 5 years only.

TABLE VI.—AVERAGE RESULTS, WARRAGUL, FOR ELEVEN YEARS, 1926–27 TO 1936–37.

| Manure per Acre. | Average Yield. | Percentage Increase. |
|---|---|---|
| | T. C. | % |
| Super., 4½ cwt. .. .. | 6 6 | **29*** |
| Super., 6 cwt. .. .. .. | 7 7 | **69** |
| Super., 6 cwt. + pot. sulp., 1 cwt. | 8 7 | **92** |
| No manure .. .. .. | 4 7 | .. |
| Super., 6 cwt. + pot. sulp., 2 cwt. | 7 9 | **64†** |
| Super., 6 cwt. + sulp. amm., 1 cwt. | 8 2 | **86** |
| Super., 6 cwt. + pot. sulp., 1 cwt. + amm. sulp., 1 cwt. .. | 8 9 | **94** |

* Three years only. † Five years only.

Warragul again stands out as being the only potato area under test in Victoria where super. and potash gives consistently greater yields than either super. alone or super. and ammonia. This year the 8-cwt. dressing of "3 and 1" super. and potash mixture (i.e., 6 cwt. super. + 2 cwt. potash) was outstanding, showing a 95 per cent. increase in yield over "no manure." Over a period of eleven years, however, the application of 6 cwt. super. and 1 cwt. potash has proved to be the most economical dressing of artificial manure, each ton increase in yield over "no manure" costing approximately 9s. 4d.

In view of the definite and satisfactory results obtained over the period during which the plots have been conducted, as well as the fact that the plot holder has ceased growing potatoes commercially, it has been decided to discontinue the tests in this district. Arrangements have been made to conduct further trials at Neerim, about 20 miles north of Warragul, which of late years has come into prominence as a potato-producing centre.

Details of returns are shown in Tables V. and VI.

## *BEECH FOREST.*

The yield at Beech Forest was exceptionally low this year, as no further growth or formation of tubers took place after the crop became badly affected with leaf blight in late March. Most of the sample dug was seed size only, but was quite clean and free from disease. Even under these conditions the results from all manurial dressings were marked, and they serve to indicate that, under conditions similar to those prevailing last season, the application of super. and ammonia at the recommended rate means the difference between total loss and a crop that will meet expenses.

Beech Forest, possibly through being in the higher rainfall area, is the only district where the heavier dressing of ammonia shows consistently greater returns. For the six-year period 9 cwt. super. + 2 cwt. sulphate of ammonia gave an increased yield of 148 per cent. over "no manure," as compared with an increase of 118 per cent. in the case of 9 cwt. super. + 1 cwt. ammonium sulphate. The cost per ton increase of these two dressings is the same, viz., 11s. indicating that the heavier dressing gives the greater net return. Figures showing the yields from the past season and the averages for the period of the trials are shown in Tables VII. and VIII.

TABLE VII.—POTATO MANURIAL TESTS, BEECH FOREST, 1936–37.

| Manure per Acre. | Weight Marketable Tubers. | Increase due to Manure. | Percentage Increase. |
|---|---|---|---|
| | T. C. | T. C. | % |
| Super., 6 cwt. .. | 2 3 | 1 11 | **258** |
| Super., 9 cwt. .. | 2 10 | 1 18 | **317** |
| Super., 6 cwt. + amm. sulp., 1 cwt. .. | 2 10 | 1 18 | **317** |
| Super., 6 cwt. + amm. sulp., 2 cwt. .. | 3 8 | 2 16 | **467** |
| Super., 9 cwt. + amm. sulp., 1 cwt. .. | 3 3 | 2 11 | **425** |
| Super., 9 cwt. + amm. sulp., 2 cwt. .. | 3 13 | 3 1 | **508** |
| Super., 6 cwt. + amm. sulp., 1 cwt., pot. sulp., 1 cwt. .. | 3 10 | 2 18 | **483** |
| No manure .. .. | 0 12 | .. | .. |

TABLE VIII.—AVERAGE RESULTS, BEECH FOREST, FOR SIX YEARS, 1931–32 TO 1936–37.

| Manure per Acre. | Average Yield. | Percentage Increase. |
|---|---|---|
| | T. C. | % |
| Super., 6 cwt. .. .. .. | 5 1 | **46** |
| Super., 9 cwt. .. .. .. | 5 12 | **61** |
| Super., 6 cwt. + amm. sulp., 1 cwt. | 7 3 | **107** |
| Super., 6 cwt. + amm. sulp., 2 cwt. | 7 15 | **123** |
| Super., 9 cwt. + amm. sulp., 1 cwt. | 7 11 | **118** |
| Super., 9 cwt. + amm. sulp., 2 cwt. | 8 12 | **148** |
| Super., 6 cwt. + amm. sulp., 1 cwt., pot. sulp., 1 cwt. .. .. | 7 1 | **103** |
| No manure .. .. .. | 3 9 | .. |

## *FISH CREEK.*

The response to artificial manures at Fish Creek was regarded as satisfactory this season, even though Irish blight caused considerable

*Showing the effect of fertilizer at Fish Creek—Left, no manure, Right, "6 and 1" mixture.*

damage in the crop. The sample was fairly even and only a small proportion of seed and chats was harvested.

The "6 and 1" mixture of super. and ammonia again proved to be the most economical dressing, in fact it has consistently given the best return from the plots since their inception. The "6 and 2" dressing gave a slightly higher yield this year, but over the period of nine years "6 and 1" has given an increase of 92 per cent. over "no manure" at a cost of 8s. 8d. per ton increase, whereas, "6 and 2" has averaged only 77 per cent. increase over the five years it has been under test.

TABLE IX.—POTATO MANURIAL TRIALS, FISH CREEK, 1936–37.

| Manure per Acre. | Weight Marketable Tubers. | Increase due to Manure. | Percentage Increase. |
|---|---|---|---|
| | T. C. | T. C. | % |
| Super., 4½ cwt. .. | 6 7 | 0 6 | 5 |
| Super., 6 cwt. .. | 6 19 | 0 18 | 15 |
| No manure .. .. | 6 1 | .. | .. |
| Super., 6 cwt. + amm. sulp., 1 cwt. .. | 8 5 | 2 4 | 36 |
| Super., 6 cwt. + amm. sulp., 2 cwt. .. | 8 8 | 2 7 | 39 |
| Super., 6 cwt. + amm. sulp., 1 cwt. + pot. sulp., 1 cwt. .. | 8 2 | 2 1 | 34 |

TABLE X.—AVERAGE RESULTS, FISH CREEK, FOR NINE YEARS, 1928–29 TO 1936–37.

| Manure per Acre. | Average Yield. | Percentage Increase. |
|---|---|---|
| | T. C. | % |
| Super., 4½ cwt. .. .. | 6 10 | 42* |
| Super., 6 cwt. .. .. .. | 7 10 | 55 |
| No manure .. .. .. | 4 17 | .. |
| Super., 6 cwt. + amm. sulp., 1 cwt. | 9 6 | 92 |
| Super., 6 cwt. + amm. sulp., 2 cwt. | 8 7 | 77† |
| Super., 6 cwt. + amm. sulp., 1 cwt. + pot. sulp., 1 cwt. .. .. | 7 11 | 56 |

* Three years only. † Five years only.

As it is now considered that the experiments have been in existence for a sufficient length of time to furnish results which may be accepted as a reliable guide by local growers, the plots in this district have been discontinued.

The results during the past season and the average returns during the full period of the tests are set out in Tables IX. and X.

## *MUSK.*

The results from the potato plots at Musk are above average this year, due to a certain extent, to the good order in which the plots were kept throughout the season. The variety sown was Snowflake, and despite the dry period

*A fine crop of Snowflakes at Musk.*

at the critical stage of flowering, the plots yielded a fair sample of good shaped potatoes, demonstrating once again that this extremely late tubering variety is eminently suitable to those districts where rainfall is unreliable.

The usual increase in favour of the combined super. and ammonia dressings was again manifest, the "3 and 2" combination being outstandingly more productive than the "3 and 1," giving an 85 per cent. increase in yield over "no manure" as compared with 45 per cent. in the case of the latter dressing. Over a period of five years, the average difference in yields produced by these two dressings is 11 cwt. per acre in favour of the "3 and 2" mixture, and when it is considered that it costs roughly 1s. per cwt. to produce this increase, the use of the heavier dressing in this area appears to be justified, especially in years when good prices obtain.

The seeming discrepancy in the percentage increases shown above, are due to the fact that the comparisons made between the "3 and 1" and "3 and 2" are taken for the same five-year period, whereas the average of the "6 and 1" is taken over a nine-year period.

The yields obtained at Musk are shown in Tables XI. and XII.

TABLE XI.—POTATO MANURIAL TESTS, MUSK, 1936–37.

| Manure per Acre. | Weight Marketable Tubers. | Increase due to Manure. | Percentage Increase. |
|---|---|---|---|
| | T. C. | T. C. | % |
| Super., 2 cwt. .. | 5 2 | 0 6 | 6 |
| Super., 3 cwt. .. | 4 19 | 0 3 | 3 |
| Super., 4 cwt. .. | 5 10 | 0 14 | 15 |
| No manure .. .. | 4 16 | .. | .. |
| Super., 3 cwt. + sulp. amm., 1 cwt. .. | 6 19 | 2 3 | 45 |
| Super., 3 cwt. + sulp. amm., 2 cwt. .. | 8 19 | 4 3 | 86 |

TABLE XII.—AVERAGE RESULTS, MUSK, FOR NINE YEARS, 1928–29 TO 1936–37.

| Manure per Acre. | Weight Marketable Tubers. | Percentage Increase. |
|---|---|---|
| | T. C. | % |
| Super., 2 cwt. .. .. .. | 4 10 | 29 |
| Super., 3 cwt. .. .. .. | 4 16 | 37 |
| Super., 4 cwt. .. .. .. | 4 18 | 40 |
| No manure .. .. .. | 3 10 | .. |
| Super., 3 cwt. + sulp. amm., 1 cwt. | 5 15 | 64 |
| Super., 3 cwt. + sulp. amm., 2 cwt. | 6 17 | 85* |

* 5 years only.

## *ILLOWA.*

Illowa, the earliest sown plot (August) conducted by this Department, was harvested in the middle of January. The variety was Manistee and it provided a good yield of first grade potatoes which were of nice size and shape and came up clean and quite free from disease. Eel worm (*Heterodera marioni*) caused some little damage, which was confined to the "no manure" sections, these being some 14 to 18 days later in maturing than the remainder of the plot. This may explain, to some extent, why the manured sections escaped damage from this source.

The satisfactory yield at Illowa may be attributed to the almost ideal season experienced there; rain fell regularly giving continuity of sufficient moisture for the crops and enabling the necessary cultivations to be given at the proper times.

Super. and ammonia again showed an increased yield over super. alone, but it is apparent from the results over a period of nine years that the heavier dressing of ammonia (2 cwt.) is not justified. The "3 and 1" mixture consistently has given the most profitable increase. It is estimated that each ton increase over "no manure" provided by this dressing costs 9s. 4d. for manure, which in almost any season yet experienced would prove profitable.

The yields obtained during last season and the average yield over the nine years of the tests

TABLE XIII.—POTATO MANURIAL TRIALS, ILLOWA, 1936–37.

| Manure per Acre. | Weight Marketable Tubers. | Increase due to Manure. | Percentage Increase. |
|---|---|---|---|
| | T. C. | T. C. | % |
| Super., 2 cwt. .. | 8 8 | 1 8 | 21 |
| Super., 3 cwt. .. | 8 13 | 1 13 | 24 |
| Super., 4 cwt. .. | 8 17 | 1 17 | 26 |
| No manure .. .. | 7 0 | .. | .. |
| Super., 3 cwt. + sulp. amm., 1 cwt. .. | 9 16 | 2 16 | 40 |
| Super., 3 cwt. + sulp. amm., 2 cwt. .. | 10 2 | 3 2 | 44 |

TABLE XIV.—AVERAGE RESULTS, ILLOWA, FOR NINE YEARS, 1928–29 TO 1936–37.

| Manure per Acre. | Average Yield. | Percentage Increase. |
|---|---|---|
| | T. C. | % |
| Super., 2 cwt. .. .. .. | 6 17 | 32 |
| Super., 3 cwt. .. .. .. | 7 9 | 43 |
| Super., 4 cwt. .. .. .. | 7 10 | 44 |
| No manure .. .. .. | 5 4 | .. |
| Super., 3 cwt. + amm. sulp., 1 cwt. | 7 18 | 52 |
| Super., 3 cwt. + amm. sulp., 2 cwt. | 6 10 | 38* |

* 4 years only.

*Showing the increased growth obtained when the manure is placed in the furrow with the seed (right), as compared with when it is broadcast (left).*

are shown in Tables XIII. and XIV. A test to determine the relative values of deep and shallow planting was also carried out in conjunction with the manurial trials. The results obtained are as follows :—

| — — | Ton. | Cwt. | Percentage Increase. |
|---|---|---|---|
| | | | % |
| Shallow planting at $2\frac{1}{2}$″ to 3″ deep | 6 | 8 | .. |
| Deep planting at $4\frac{1}{2}$″ to 5″ deep | 7 | 0 | 9 |

## *Koroit.*

The plots at Koroit, situated on black volcanic flats near Illowa, were harvested on 13th March. The variety used was Snowflake and the yields, while good, did not show much variation between the manurial treatments. This was due probably to the fact that early rains, which caused a heavy growth of haulm, were followed by very dry conditions during March and April. This caused the tops to die off unusually early.

From the results obtained, over a period of seven years, it is indicated that the soil of the Koroit plot is not responsive to the heavier dressing of ammonia as the application of the extra 1 cwt. per acre provides, on the average, no increase in yield. It would seem, then, that the "3 and 1" combination is the best fertilizer to use at Koroit, it having been most consistent in maintaining a satisfactory increase in yield over the "no manure" areas.

Last season's yields together with the results obtained during the seven years of the tests are set out in Tables XV. and XVI.

TABLE XV.—POTATO MANURIAL TESTS, KOROIT, 1936–37.

| Manure per Acre. | Weight Marketable Tubers. | Increase due to Manure. | Percentage Increase. |
|---|---|---|---|
| | T. C. | T. C. | % |
| Super., 2 cwt. .. | 8 16 | .. | .. |
| Super., 3 cwt. .. | 9 6 | 0 5 | 3 |
| Super., 4 cwt. .. | 9 4 | 0 3 | 1·5 |
| No manure .. .. | 9 1 | .. | .. |
| Super., 3 cwt. + sulp. amm.. 1 cwt. .. | 9 6 | 0 5 | 3 |
| Super., 3 cwt. + sulp. amm., 2 cwt. .. | 9 17 | 0 16 | 9 |

TABLE XVI.—AVERAGE RESULTS, KOROIT, FOR SEVEN YEARS, 1928–29 TO 1935–36.

| Manure per Acre. | Average Yield. | Percentage Increase. |
|---|---|---|
| | T. C. | % |
| Super., 2 cwt. .. .. .. | 7 1 | 17 |
| Super., 3 cwt. .. .. .. | 7 6 | 21 |
| Super., 4 cwt. .. .. .. | 7 6 | 21 |
| No manure .. .. .. | 6 0 | .. |
| Super., 3 cwt. + sulp. amm., 1 cwt. | 7 13 | 27 |
| Super., 3 cwt. + sulp. amm., 2 cwt. | 8 10 | 24* |

* 4 years only.

# *Processing of Prunes*

*Report submitted by the Fruit Processing Committee.* *

## Varieties of Plums.

WHILE d'Agen and Robe de Sargeant are recognized varieties for prune production, others are known to produce a satisfactory prune, but some are definitely not suitable. From this point of view plums may be divided into two classes :—

*Suitable for drying*: d'Agen, Robe de Sargeant, Splendour, French, Fellenberg (Italian), Imperial, and Sugar.

*Definitely unsuitable for drying*: Golden Drop, Angelina Burdett, President, Giant, and Grand Duke.

## Cultural Methods.

Emphasis should be laid on the fact that cultural methods play an important part in prune quality. Although not directly connected with processing, they obviously have a very important bearing on the quality of fresh fruit, and this is a first essential in the production of high grade prunes. Particular attention should therefore be paid to pruning, thinning, &c., and to such general cultural methods as are necessary to ensure first class fruit. It has been noted that under present cultural conditions in many districts the majority of the plums at harvest are small and light, and that there is a marked variation in size, colour, and sugar content at the time of maturity of the plums on each tree. A uniformly high quality pack is not possible under these conditions.

## Elimination of Unsuitable Fruit in the Field.

The first plums to ripen are, as a rule, somewhat deficient in sugar. This premature drop of plums that are coloured but are not matured should be cleared from beneath the trees to prevent the contamination of mature fruit falling later, and should be disposed of immediately they have been processed.

Apart from these first-ripening plums, fresh fruit, ready for drying, may be divided into three classes, viz., (1) wilted, or fruit which ripens and wilts on the tree and then drops; (2) full-ripe which has not wilted; and (3) unripe. It has been definitely established that with most varieties the first class produces the highest quality prune and, further, that there is a fairly high proportion of unripe fruit in a crop which, if not separated, will materially reduce the general quality of the pack.

Plums should therefore be allowed to ripen and drop from the tree and collected every two or three days. Any shaking of the branches should be very gently performed, so as to lessen the chance of bringing down immature plums. In order to produce a pack of the highest quality, it is essential to grade the plums at harvest into two classes, wilted and full-ripe, which should be kept separate, and all other fruit must be discorded. This initial grading must be done if high quality, with resultant higher prices, is to be obtained.

## Dipping Prior to Drying.

The dipping process is by no means standardized, and the best French prunes are not dipped at all. When practised, prunes are dipped as soon as possible after gathering, the usual dip being the caustic one containing 1 lb. of soda in from 12 to 30 gallons of water. The correct strength depends on variety, maturity, and climatic conditions, and can be determined only by trial. In fact, there is evidence to suggest that a much weaker dip (1 lb. of caustic soda in 50 gallons of water) will give satisfactory results, provided it is kept boiling continuously. A constantly boiling dip is essential, and there is general agreement that it should very slightly crack the skin of most of the prunes.

Cracking of the skin should be barely noticeable; any more pronounced cracking is undesirable. The dip is momentary, and when the prunes are taken from it they should be spread on trays at once. Dips other than the caustic dip have been tried, and it would appear that, within limits, the nature of the dip is relatively unimportant.

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* The members of the Fruit Processing Committee are:—Mr. W. R. Jewell, Agricultural Research Chemist, Department of Agriculture, Victoria (Chairman); Mr. A. V. Lyon, Commonwealth Research station, Merbein; Mr. C. G. Savage, Director of Fruit Culture, N.S.W.; Mr. A. G. Strickland, Chief Horticultural Officer, S.A.; Mr. West, Research Station, Griffith, N.S.W.; Mr. D. G. Quinn, Viticulturist, Victoria (Secretary).

### Drying.

If the weather be very hot, trays should first be stacked to prevent "case hardening" and "boiling" of the fruit with the loss of juice, after which they are generally exposed to the sun, except in very hot periods. Prunes are also dried on single-tier, wire-netting racks, in which case they dry more slowly but are not liable to the same degree of damage by rain. Information is lacking as to the optimum moisture content desirable at the completion of the drying period, but the prune must be sufficiently dry to store indefinitely in bulk and to allow the addition of further moisture during processing. A slightly harsh condition at this stage is safest if deterioration on storage of the desirable blue-black colour is to be prevented. This harsh condition is only temporary and will disappear with further processing and moistening, but should be guarded against in fruit intended for immediate sale.

### Sweating.

When dry, prunes are suitably stored in bulk for five or six weeks while slight fermentation takes place and the product assumes a uniform moisture content. Care should be taken to turn the fruit from time to time. This can be conveniently carried out by tipping the contents from one box into another.

### Factory Processing.

Apart from size grading and hand picking of faulty fruit, it should be an invariable practice to process dried prunes with a view to increasing the moisture content and producing a moist pack. This may be done by steaming or dipping. It is probably undesirable to add to the dip bath many of the concoctions that are now employed, but certain simple additions may be of benefit. When dipping, the prunes (in a wire basket) should be totally submerged in boiling water. The period of dipping depends on the condition of the dried prunes and may extend to three minutes with very dry fruit. The dipped prunes are thickly spread on drying trays or sweat boxes. As soon as the surface of the prunes is dry, they should be packed.

From the information available, it would appear that the moisture content of the processed prune should range from 20 to 25 per cent. With moisture contents greater than 25 per cent. moulds are liable to develop. Recently-processed prunes are more attractive than those which have been processed for some time, so that it is desirable that dry prunes should be processed progressively according to market requirements. After prolonged storage, prunes which have become unattractive may be re-processed with advantage.

In order to produce a uniform pack by a standard procedure it is desirable to process prunes at one central factory rather than at a large number of small centres.

### Dessert Prunes.

The foregoing remarks on factory processing refer primarily to boxed prunes. The following procedure for dessert prunes is that recommended by the Director of Fruit Culture, New South Wales Department of Agriculture :—

The prunes, as they come from the sweat after completion of drying, should be thoroughly graded ; only the larger prunes should be processed as desert prunes (as a rule greater counts than 60–70 should not be used).

The prunes, in dipping baskets, should be thoroughly rinsed in cold water, and then placed in sweat boxes and allowed to "cold sweat" for at least 36 hours. If convenient, sufficient can be dipped to last two or three days processing, as prunes are not harmed by holding them in a moist state for a few days, and possibly may be improved. They should then be exposed direct to steam at a pressure of 5 lb. for a period long enough to render the skin quite tender and the flesh soft. During steaming the prunes should be held in wire dipping baskets or some receptacle that will allow the steam to circulate freely amongst them. The period of steaming necessary will vary with the condition of the prune and can be determined only by test. From trials to date the variation may be from 10 to 25 minutes. The length of period necessary can be arrived at by testing several prunes between the front teeth at intervals until the required tenderness of skin is reached. The skin should be sufficiently tender to offer no appreciable resistance to the teeth when bitten. When steaming is completed the prunes should be packed whilst hot into lacquered cans. The skin of the steamed prune will toughen appreciably if the fruit is allowed to cool for more than fifteen minutes.

When packed, the cans are exhausted, sealed, and sterilized. Ten minutes exhausting with vents open, partially submerged in a boiling bath, and 25 minutes sterilizing with vents closed, totally submerged in boiling bath, was found satisfactory for cans 5 inches by 4 inches overall packed with 29 oz. of steamed prunes. Fifteen minutes exhausting with vents open, partially submerged in boiling bath, and thirty minutes sterilizing

with vents closed, totally submerged in boiling bath, was found satisfactory for cans 7 inches by 6¼ inches overall, packed with 6¼ lb. steamed prunes.

Where facilities for steaming under pressure are not available, the prunes may, after cold wet sweating, be dipped in boiling water to soften the skins and flesh. The length of the period of dipping must be judged in a similar manner as for steaming. Generally, however, dipping cannot be extended much beyond twelve minutes, as the prunes commence to break up. When dipping is completed the prunes are packed while still quite hot, and the cans exhausted and sterilized as already described.

Prunes cooked in this way have a distinctly different flavour from those cooked by steam, which may suit some palates, but they lack the glossy appearance of the steamed prune, which is apparently preferred by the consumer. Consequently the boiling water dip cannot be considered a satisfactory method commercially.

Tests have shown that processed dessert prunes, when turned out of the can, will remain in satisfactory soft condition for 36 hours, and if allowed to remain in the open can, for 72 hours. After these periods the skin of the prune toughens appreciably. It can therefore be judged that if the processed prunes are packed in a container that is not airtight, such as a carton, the prunes will need to be consumed within three days of packing. Otherwise the skin of the prunes will become too tough for dessert prunes and the fruit could only be classed as stewing prunes.

# *Seed Certification*

## *Summary of Operations for 1936-37*

FOR several years rye grass growers' associations at Colac, Clunes, and Kyneton have been sealing and certifying locally-grown seed which was the produce of areas inspected and approved by officers of the Department of Agriculture. During the past season the Department increased its services, and in addition to inspecting areas and registering those approved, officers supervised harvesting and cleaning, and then sealed and tagged the bags of seed, thus enabling growers and merchants to place the seed on the market as Government Certified seed. The work involves paddock sealing of the seed off the thresher or harvesting machine and its subsequent final re-sealing after it has been cleaned under supervision.

The scheme has been extended to cover Phalaris tuberosa, Tallarook subterranean clover, and Irrigation white clover, in addition to perennial rye grass.

The methods of working of the seed certification schemes in operation in Victoria were described in an article in this Journal for March, 1937.

The following table shows the quantity of seed of each kind finally sealed during the first season of the operation of seed certification in Victoria :—

| | |
|---|---|
| Perennial Rye Grass— | |
| Colac and District. Certified seed .. .. .. | 10,347 bush. |
| Clunes and Smeaton Districts. Certified seed .. .. | 24,594 bush. |
| Kyneton and District. Certified seed .. .. | 1,795 bush. |
| Total .. .. | 36,736 bush. |
| Tallarook Subterranean Clover— | |
| Tallarook. Certified Mother seed .. .. .. | 28,044 lb. |
| Warncoort. Certified seed | 9,740 lb. |
| Total .. .. | 37,784 lb. |
| Phalaris tuberosa— | |
| Dandenong. Certified Mother seed .. .. .. | 3,970 lb. |
| Irrigation White Clover— | |
| Dingee. Certified seed .. | 270 lb. |

Growers wishing to submit areas for inspection with a view to certification of the seed produced from them during the coming season are requested to make application for inspection with as little delay as possible. It will be necessary for them to make application to the Director of Agriculture by the 1st November, on a form which is obtainable from the Department of Agriculture. A fee of £1 1s. is payable on application for seed certification.

# "Moist-Pack" Processing of Dried Apricots*

A few years ago apricots were packed bone-dry, but it has now become a general custom to market a "moist" pack; this is preferred on the overseas market and has become established at home. The production of a satisfactory moist-pack apricot involves certain processing problems which have not yet been fully solved by all packing sheds, as a satisfactory product which will retain its colour on storage has not always been produced. Attention is therefore drawn to the following points which have an important bearing on the question and which must be observed in order to obtain the best results in moist-packing.

## Grading.

Grading in the packing shed is essential to secure an attractive and uniform product. Reports from oversea's markets stress the necessity for **more consistent** grading both for colour and size. In addition to size-grading, picking out of faulty pieces by hand seems essential.

## Moistening.

Moistening may be accomplished by immersion in water at 180° C., or by steaming followed by partial drying. The length of time of immersion or steaming depends on the condition of the apricot and can be determined only by trial. There is a limit to which the moisture can be raised consistent with successful keeping qualities during export or storage. This limit is from 20 to 25 per cent. of moisture, and the lower limit should be observed for export fruit. It would appear from this that the determination of moisture in processed fruit should be a regular procedure in a packing shed; it is difficult to see how otherwise the moistening process can be adequately controlled or a uniform product turned out from day to day. At present there is no very rapid method for determining moisture content, but experiments are under way to ascertain whether the electric moisture meter can be adapted to this purpose.

## Sulphur Content.

Undoubtedly the sulphur content is the outstanding factor concerned with the retention of a bright colour in moist-pack apricots, which lose sulphur dioxide more quickly than do bone-dry ones. Last season in a number of instances darkened apricots were examined and the sulphur dioxide was invariably about 1 grain per lb. or less. There was, in fact, a correlation between degree of darkening and sulphur content. It is therefore essential that moist-packed apricots, immediately after processing, should contain right up to the limit of 14 grains sulphur dioxide per lb.

To ensure this, two courses are open. Either oversulphured dry apricots should be selected, or resulphuring after processing must be employed. With the widespread adoption of moist-packing, it will be obvious that the latter procedure must generally be followed. In either case, a knowledge of the sulphur content both before and after processing is an absolute essential if a uniform and satisfactory product is to be obtained. Without such knowledge moist-packing must be haphazard, with the deterioration and wastage frequently experienced in the past with hit-and-miss methods.

A rapid workshop method was published in the *Australian Dried Fruits News* of the 26th December, 1936. For this technical training is not necessary, and it appears to be sufficiently accurate and rapid for its purpose. The method is reprinted in detail in the appendix to this article. Packers are urged to use this, or some other method, to determine the sulphur content of every consignment of apricots prior to treatment, and to check the accuracy of the resulphuring by a further test after resulphuring. It is even desirable to give a further sulphuring if the product does not contain approximately 14 grains per lb. The procedure to be adopted for resulphuring cannot as yet be closely prescribed, but must be determined by experience, as the amount of sulphur and time of exposure

* Report prepared by W. R. Jewell, Agriculture Research Chemist, Department of Agriculture, and issued by the Fruit Processing Committee.

will depend on the sulphur content of the dry apricots and on the extent of moistening. After data have been collected for some time, correlating sulphur content of dry apricots with moistening and resulphuring details, it should be soon possible to lay down a procedure suitable for any given type of dry apricots.

### Storage.

From statements made earlier, it will be obvious that moist-pack apricots tend to deteriorate relatively quickly, and therefore arrangements should be made for their prompt sale on arrival at destination. Unnecessary storage should be avoided, and in spite of alleged difficulties, it is advisable to moist-pack progressively throughout the year as demand requires, preferably immediately prior to sale. If all apricots are moist-packed at the end of the drying season, wastage must be expected in those subjected to prolonged storage.

Evidence is also available that climatic conditions during storage play an important part. Apricots containing 18 per cent. moisture and 12 grains sulphur dioxide per lb. retained their colour and generally attractive appearance when stored for about four months in Melbourne; but a portion of the same box stored for the same period in the north of Queensland darkened to such an extent that the fruit was unmarketable. Under such conditions It would appear that no attempt should be made to store moist-pack apricots and that dry-pack apricots are preferable. With all types of apricots, storage under dry, well sheltered conditions gives the best results.

### Salvaging Darkened Fruit.

At the request of the Australian Dried Fruits Association, an investigation was undertaken to ascertain if badly darkened fruit could be so treated as to restore its former colour. After trying a number of treatments it was found (rather contrary to expectations) that immersion in warm water for about ten minutes, followed immediately by resulphuring, restored the bright colour to a remarkable degree even in the case of very dark fruit. Although the treatment, as would be expected, did not produce as attractive a product as originally, it was sufficient last season to render marketable a very large number of boxes which had been classed as unsaleable owing to the development of a dark colour.

In this treatment, apricots should be classed, as far as possible, according to colour, and those of one colour treated separately. An inspection at intervals during sulphuring will indicate what degree of sulphuring is necessary. After treatment, hand picking will probably be necessary to eliminate the few pieces which have not responded to treatment; these should be included in the next lot treated.

### Conclusion.

Two main points should be stressed. It is definite that a satisfactory and uniform product cannot be obtained without controlling both moisture and sulphur content, which is impossible without some degree of chemical control. In the second place, deterioration of moist-pack apricots must be expected on storage; therefore apricots should be processed only to meet market requirements.

### *Appendix.*

#### *Simple "Workshop" Method for the Determination of Sulphur Dioxide in Dried Apricots.*

A simple method, to be satisfactory, must be approximately accurate, sufficiently simple to be conducted by an intelligent member of the packing shed staff, and as rapid as possible. That such a method is feasible was indicated by the writer in an article appearing in this *Journal* for February, 1931, page 90. The method has been further investigated and, after slight modification, found to fulfil the conditions set out above. It is described below.

*Solutions required:*

*One-tenth normal iodine solution* containing 12·7 grammes of iodine and 18 grammes of potassium iodide per litre. To be kept in a brown or blue coloured bottle.

*Starch solution* prepared by adding one teaspoonful of potato starch to about two cups of boiling water. Boiling should be continued for few minutes. To be made fresh daily.

*Apparatus required:*

*Stoppered bottles.*—A number of wide-mouthed glass-stoppered bottles of about 600 c.c. capacity. In an emergency, screw-stoppered lemonade bottles will do, but are not nearly so convenient as the wide-mouthed glass-stoppered bottles.

*Burette.*—One 50 c.c. burette.

*Rough chemical balance* and set of gramme weights.

*Small mincer.*

*Burette stand.*

*Method:*

Exercise care in obtaining a representative sample, which should then be "quartered down" until about ¼ lb. remains. Pass this twice through a small mincer.

Weigh carefully 44 grammes of the minced sample and transfer to the stoppered bottle. Add about 500 c.c. (say two cups) of water. Insert stopper and shake well every ten minutes until two hours have passed. Add about a teaspoonful of the starch solution, and then run in iodine solution from the burette. The iodine solution should be added in small amounts, 1 c.c. at a time towards the end of the titration; shake vigorously for fifteen seconds after each addition. The titration is finished when the blue colour produced by the last addition of iodine persists after fifteen seconds shaking.

Each c.c. of iodine used represents 1 grain per lb. of sulphur dioxide, so that the sulphur dioxide content is simply the burette reading in c.c.

*Note :*

(1) A green colour shows that too little starch solution has been added. Repeat test with more starch.

(2) If gramme weights are not available, a 2-oz. sample may be used ; in which case the number of c.c. of iodine used multiplied by ·78 gives grains of sulphur dioxide per lb.

(3) The iodine solution and the apparatus may be obtained from suppliers of chemical apparatus at a small cost.

(4) The method is admittedly approximate. For the purpose in view it is sufficient to know the sulphur dioxide content to within plus or minus 1 grain per lb.

(5) By using several bottles, a considerable number of determinations can be made in a relatively short time.

(6) The method is obviously an empirical one, and it is therefore essential that the directions be adhered to rigidly.

# *Tubercle Free Herds*

The following herds have been declared free of tuberculosis under the scheme conducted by the Department of Agriculture. Under this scheme a tuberculosis-free accredited herd of cattle is one in which the entire herd has passed two negative, successive, annual physical examinations and tuberculin tests, or, upon disclosure of infection, three semi-annual, successive physical examinations and tuberculin tests applied by a State Veterinarian or by a qualified and registered veterinarian who is approved by the Chief Veterinary Inspector for that purpose.

ACCREDITED TUBERCLE FREE HERDS.

| Herd Number. | Name. | Address. | Number in Herd. | Herd Number. | Name. | Address. | Number in Herd. |
|---|---|---|---|---|---|---|---|
| 1 | State Research Farm | Werribee .. | 259 | 6 | Lady Talbot Milk Supply Company | Cranbourne | 418 |
| 2 | Warragul High School | Warragul .. | 35 | 7 | Mailer, Dr. Ramsay .. | "Maneroo," Shepparton | 92 |
| 3 | Payne, A. E. T. .. | "Yarra View," Lilydale | 80 | 8 | Reid, Ralph G. .. | "Holmwood," Koo-wee-rup | 99 |
| 4 | Dennis, Mrs. A. A. .. | Frankston .. | 14 | 9 | Harris, J. W. .. | "Rowena," Clyde | 72 |
| 5 | Slaney, H. B. .. | Mornington .. | 85 | | | | |

# *Drenching a Horse.*

The administration of medicine, in the form of a drench, to a horse is often necessary. Care in administration is essential. The head of the horse should be raised slightly above the horizontal by means of a loose loop of rope around the top jaw, the other end of the rope being drawn over a convenient rafter, &c.

The drench is best given from a long-necked copper-drenching bottle. Care must be taken not to give the drench too quickly—not more than the horse can conveniently swallow at one time should be poured into his mouth.

If the animal should cough the head should be lowered immediately. The practise of drenching a horse down the nostril cannot be too strongly condemned.

# *Codling Moth and Williams Pears*

## *Control Methods Investigated*

*A progress report of Investigations conducted into the problem in the Goulburn Valley, 1936–1937, by R. T. M. Pescott, M. Agr.Sc. Entomologist, and L. W. Miller, B. Agr.Sc. Assistant Entomologist.*

DURING the past few years, growers of pears in the Goulburn Valley have suffered considerable losses due to the ravages of the Codling Moth (*Cydia pomonella* L.). The variety of pear most concerned is Williams Bon Chretien, which is the only canning variety grown in that area. It has been estimated by leading growers and executive members of Fruitgrowers' Associations of the district that losses of up to 20 per cent. of the total crop are common. This loss is a serious one at the moment, when it is considered that it amounts to approximately £20,000 per annum. It really goes further than this, as there have been increased plantings of Williams pears over the past few years in view of the fact that the London market is prepared to take an increased quantity of canned pears.

Up to 31st October, 1935, it was estimated that there were 2,397 acres of bearing Williams pears in the Goulburn Valley, with a further 497 acres not bearing at that time. Therefore unless satisfactory control measures for the codling moth are quickly determined, the annual monetary losses may be expected to be even greater in the near future.

An investigation into the measures being adopted by fruitgrowers in the Goulburn Valley to combat this pest revealed that there was no uniformity in their operations. Some growers were spraying twice only during the season while others were spraying up to eight times yearly; some were spraying with arsenate of lead only, while others were using combinations of arsenate of lead and white oil or nicotine sulphate; some were using bandages as supplementary measures to spraying, while others were relying on spraying only. Then again the majority of growers appeared to be applying sprays without any definite reference to the activities of the insect. It was thus apparent that there was a definite and urgent need for an investigation to be conducted into the problem to determine a standard procedure by means of which losses due to this insect could be reduced to a minimum.

In response to a request from the Northern Victoria Fruitgrowers' Association, and with funds made available from a Commonwealth grant of £20,000 for research and advisory work in relation to the Apple and Pear Industry, a program of work for a two years' investigation into the control of the codling moth as affecting Williams pears was drawn up, and the work commenced during 1936.

The site chosen for that portion of the investigation involving field work was at Ardmona, where Messrs. Turnbull Bros. kindly placed portion of their orchard at the disposal of the Victorian Department of Agriculture. The portion of the orchard used consisted of 1,024 trees of the Williams variety in one solid block of 32 trees square for spraying trials (see attached plan), the whole block being very uniform in appearance and consisting of trees 26 years of age and in full bearing. In addition, a small section of 80 trees adjoining the main block was utilized for bandaging experiments. The laboratory work was centred at a laboratory at the Ardmona Cannery, Mooroopna.

The following progress report sets out the results obtained from the first year of the investigation.

### *Life History Studies.*

Studies of the life history of the codling moth in the Goulburn Valley were conducted in (*a*) the laboratory, and (*b*) the orchard.

#### Laboratory Studies.

Large numbers of over-wintering larvae were collected from district orchards, transferred to the laboratory, and allowed to spin up in corrugated cardboard strips from which moths emerged naturally later. Daily emergences of moths were recorded, the moths sexed, and then transferred to breeding cylinders for oviposition records.

The cylinders used (see Fig. 1) were similar to those used by Rosenberg of the Farnham House Laboratory and described by Thompson (4). They consisted of reinforced cardboard 10 inches in length and 8 inches in diameter, lined completely internally with white paper, the ends being covered with sheets of thin cellophane.

A 10 per cent. sugar solution was used as a food supply for the moths. Oviposition occurred on the lining paper and on the cellophane ends. Each day the moths were transferred to fresh cylinders, and the number of eggs deposited in the old cylinder determined. These eggs were then cut out on strips from the paper and cellophane lining, labelled, placed in petri dishes and allowed to develop normally.

The period of incubation was determined for each egg, note being taken of the development of the "black spot" stage, this stage representing the evidence of the fertility of the egg and showing actually the head capsule of the young larvae through the egg covering. When the eggs had reached this "black spot" stage they were placed in a muslin covered jar on pear fruits (see Fig. 2), allowed to hatch, and the resulting larvae allowed to feed through normally on the tissue of the fruit.

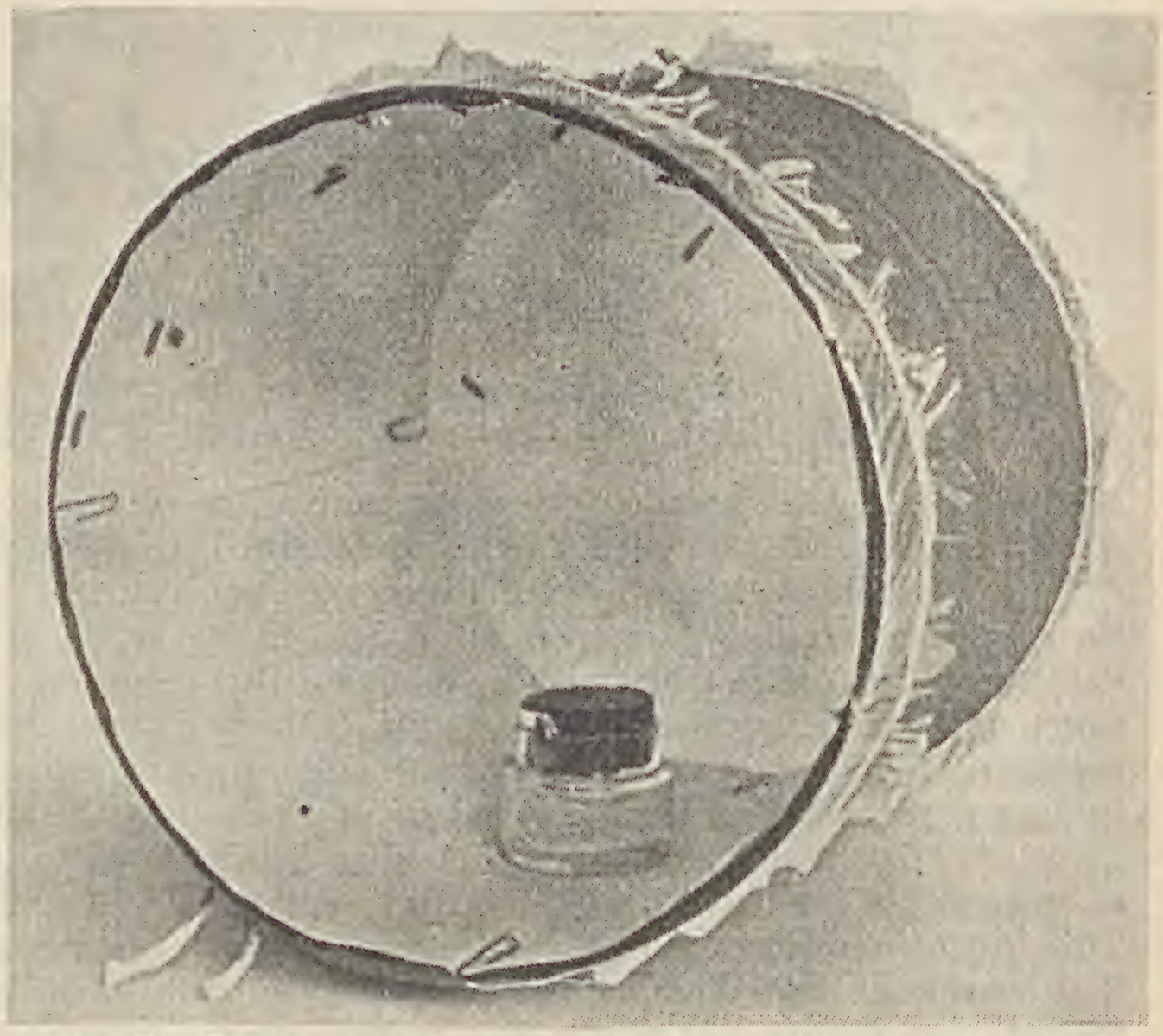


*Fig. 1.—The type of breeding cylinder used in the laboratory tests.*

In the case of the first brood, six black spotted eggs were placed on each fruit in an effort to effect an economy of space, due to the large number of larvae to be handled. When the larvae were fully grown, however, it was found that one larva only per jar was recovered, there being very definite suspicions of cannibalism. This was verified later when one mature larva was detected in the process of devouring a less mature one.

When the fully grown larvae left the fruit, they were immediately placed in small glass vials, 3 inches by $\frac{5}{8}$ inch, stoppered with cotton wool, and allowed to spin up against the walls of the vial (see Fig. 3). In this way, the prepupal period was readily observed. The moths were allowed to emerge normally in these vials, and later transferred to oviposition cylinders as previously described. This life history work was then continued throughout the remainder of the season as above, with the exception that one larva only was allowed to feed and mature in the fruit.

*Fig. 3.—A pupation tube.*

*Fig. 2.—A muslin covered larval feeding jar.*

The details of the number of broods of codling moth in the laboratory, and of each stage of each brood, are set out in Table I. It can be seen that there were two distinct broods of moths in which viable eggs were produced, i.e., the spring brood and the first brood. A few only second brood moths were produced which failed, however, to oviposit. The average period for egg to adult in the first brood was 57·61 days, while for the second brood the corresponding period was 47·00 days.

TABLE I.—SUMMARY OF DATA OF THE LIFE HISTORY OF THE CODLING MOTH, MOOROOPNA, VICTORIA, 1936–37.

| Period. | Days. | | |
|---|---|---|---|
| | Minimum. | Maximum. | Average. |
| *Spring Brood.* | | | |
| Preoviposition period .. | 2 | 12 | 4·85 |
| Oviposition period .. | 1 | 20 | 10·70 |
| *First Brood.* | | | |
| Incubation period of eggs | 5 | 13 | 10·22 |
| Feeding period of larvae | 19 | 51 | 27·35 |
| Prepupal period .. | 2 | 15 | 6·79 |
| Pupal period .. .. | 9 | 24 | 14·63 |
| Egg—Adult period .. | 48 | 85 | 57·61 |
| Preoviposition period .. | 2 | 13 | 4·31 |
| Oviposition period .. | 1 | 13 | 4·97 |
| *Second Brood.* | | | |
| Incubation period of eggs | 3 | 11 | 6·46 |
| Feeding period of larvae | 14 | 35 | 22·21 |
| Prepupal period .. | 2 | 11 | 5·38 |
| Pupal period .. .. | 9 | 16 | 11·14 |
| Egg-Adult period .. | 38 | 55 | 47·00 |
| Preoviposition period<br>Oviposition period | The moths of this brood failed to oviposit. | | |

Of the first brood, 7·14 per cent. of the larvae over-wintered, and of the second brood 87·72 per cent. passed through the same period.

In Table II. is set out the length of time lived by the different sexes for both the spring and first broods.

TABLE II.—SUMMARY OF DATA RELATIVE TO THE LENGTH OF LIFE OF THE SEXES IN THE DIFFERENT BROODS, 1936–37.

| — | Days. | | |
|---|---|---|---|
| | Minimum. | Maximum. | Average. |
| *Spring Brood.* | | | |
| Life of males .. .. | 2 | 32 | 11·45 |
| Life of females .. | 3 | 32 | 13·18 |
| *First Brood.* | | | |
| Life of males .. .. | 1 | 16 | 6·56 |
| Life of females .. | 2 | 16 | 8·55 |

The percentage of sexes in the moths of the spring brood and the first brood is shown in Table III., while in Table IV. is set out the number of eggs produced per female in respect to the various broods in the laboratory for the 1936–37 season.

TABLE III.—THE PROPORTIONS OF SEXES PRESENT IN THE DIFFERENT BROODS, 1936–37.

| — | Percentage of Males. | Percentage of Females. |
|---|---|---|
| Spring Brood .. .. | 48·33 | 51·67 |
| First Brood .. .. | 48·37 | 51·63 |

TABLE IV.—THE NUMBER OF EGGS PRODUCED PER FEMALE FROM THE VARIOUS BROODS, 1936–37.

| — | Eggs. | | |
|---|---|---|---|
| | Minimum. | Maximum. | Average. |
| Spring Brood .. .. | 0 | 25 | 5·34 |
| First Brood .. .. | 0 | 45·5 | 5·16 |
| Second Brood .. .. | The second brood moths did not oviposit. | | |

TABLE V.—DATES OF EMERGENCES OF THE VARIOUS BROODS, 1936–37.

| — | First Emergence. | Last Emergence. | Peak of Emergence. |
|---|---|---|---|
| Spring brood .. | 12.10.36 | 29.11.36 | 5.11.36 |
| First brood .. | 30.12.36 | 31.1.37 | 12.1.37 |
| Second brood (very small emergence of moths) .. | 2.3.37 | 12.3.37 | .. |

It will be seen from a study of the figures in Table IV. that the average number of eggs produced per female is low. This can possibly be explained by the fact that the humidity inside the cardboard cylinders was low, it being impossible to make any provision for increasing the humidity artificially. For the same reason it is probable that the length of life of the various sexes as shown in Table II. is low. In future laboratory life history studies, it is intended to modify the type of breeding cylinder used so that humidity conditions can be made more suitable.

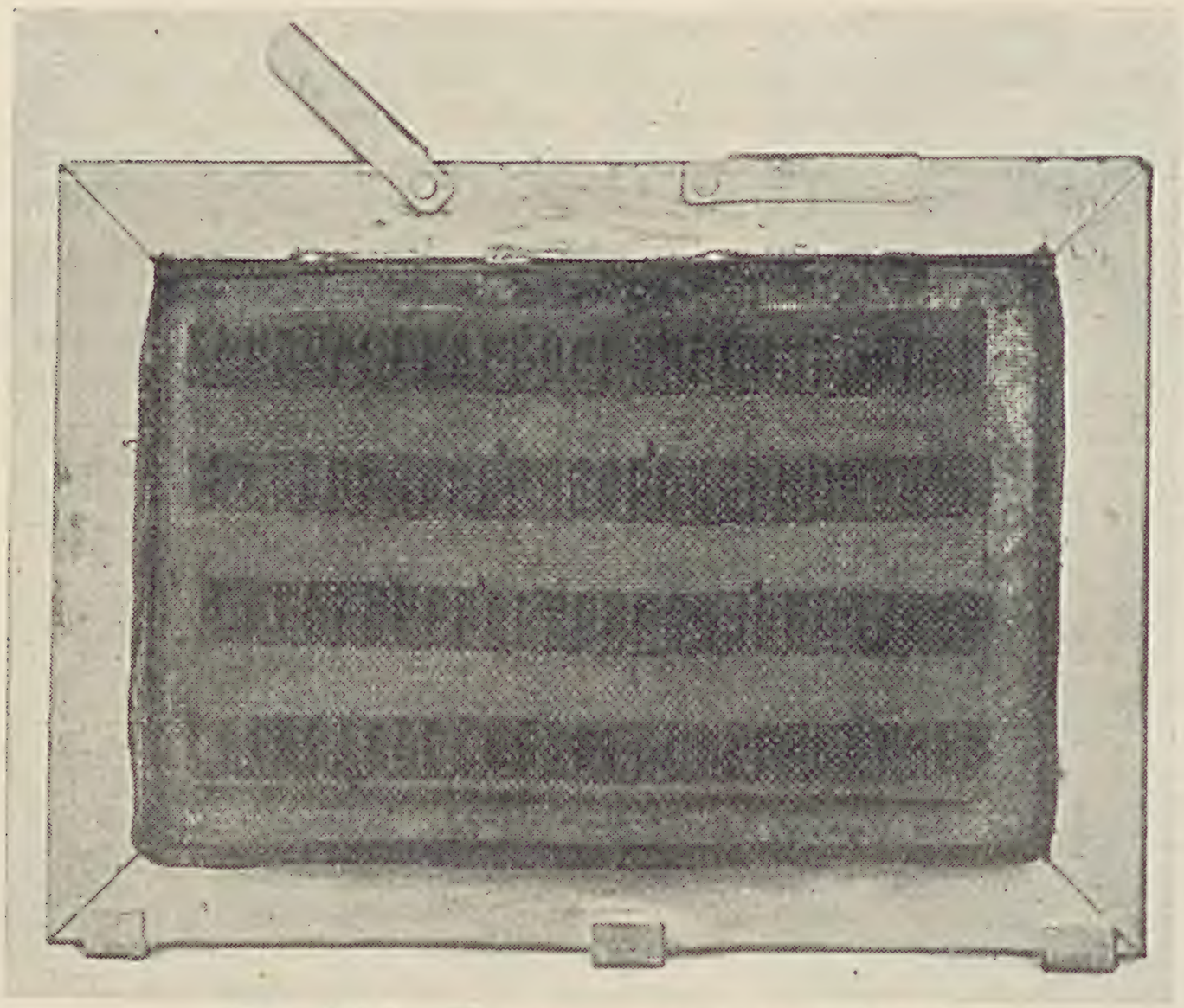


*Fig. 4 (a).—The emergence cage—closed.*

In Table V. are set out the figures for the dates of emergences of the spring brood, first brood, and second brood moths.

### Field Studies.

In the field the life history studies consisted of observing the emergence of moths in emergence cages placed out in the open adjacent to the spraying block. The emergence cage designed along the lines as used by Peterson and Haeussler (3) is shown in Figs. 4*a* and *b*. Four of these cages were used, being attached to posts in the orchard at a height of 30 inches above ground level to the centre of the cage. This distance was chosen as being comparable with the position of the maximum number of larvae on a tree. The cages were so arranged on the posts that there was one cage facing each of the cardinal points of the compass.

Approximately, 100 cocooned larvae were placed in each cage. These were allowed to emerge normally as moths, the number of such emergences being determined twice a week. Table VI. sets out the first and last emergences together with the peak of the emergences for the spring brood only. The details of these emergences and the total emergences are shown on Graph 1. Here, the emergences are plotted against maximum and minimum daily temperatures.

It can be seen from a study of Graph 1, that the first emergence occurred in the cage facing east (on 19.10.36) and the total emergence was completed earlier in this cage than in any other. Emergences from the north cage occurred next in order (the first on 22.10.36), then following the west cage, and at a much later date the south cage. This was more or less as expected, as the eastern and northern cages would receive the greatest amount of sunlight and heat, whereas the southern cage would get the minimum. The fact of the varying emergences from these cages can perhaps partly explain the prolonged emergence of any particular brood from the trunks

Table VI.—Summary of Emergences of Moths from Emergence Cages in the Field. Ardmona, 1936.

| — | First Emergence. | Peak of Emergence. | Last Emergence. |
|---|---|---|---|
| North .. .. | 22.10.36 | 9.11.36 | 19.11.36 |
| South .. .. | 5.11.36 | 9.11.36 to 16.11.36 | 3.12.36 |
| East .. .. | 19.10.36 | 5.11.36 | 19.11.36 |
| West .. .. | 26.10.36 | 9.11.36 | 19.11.36 |

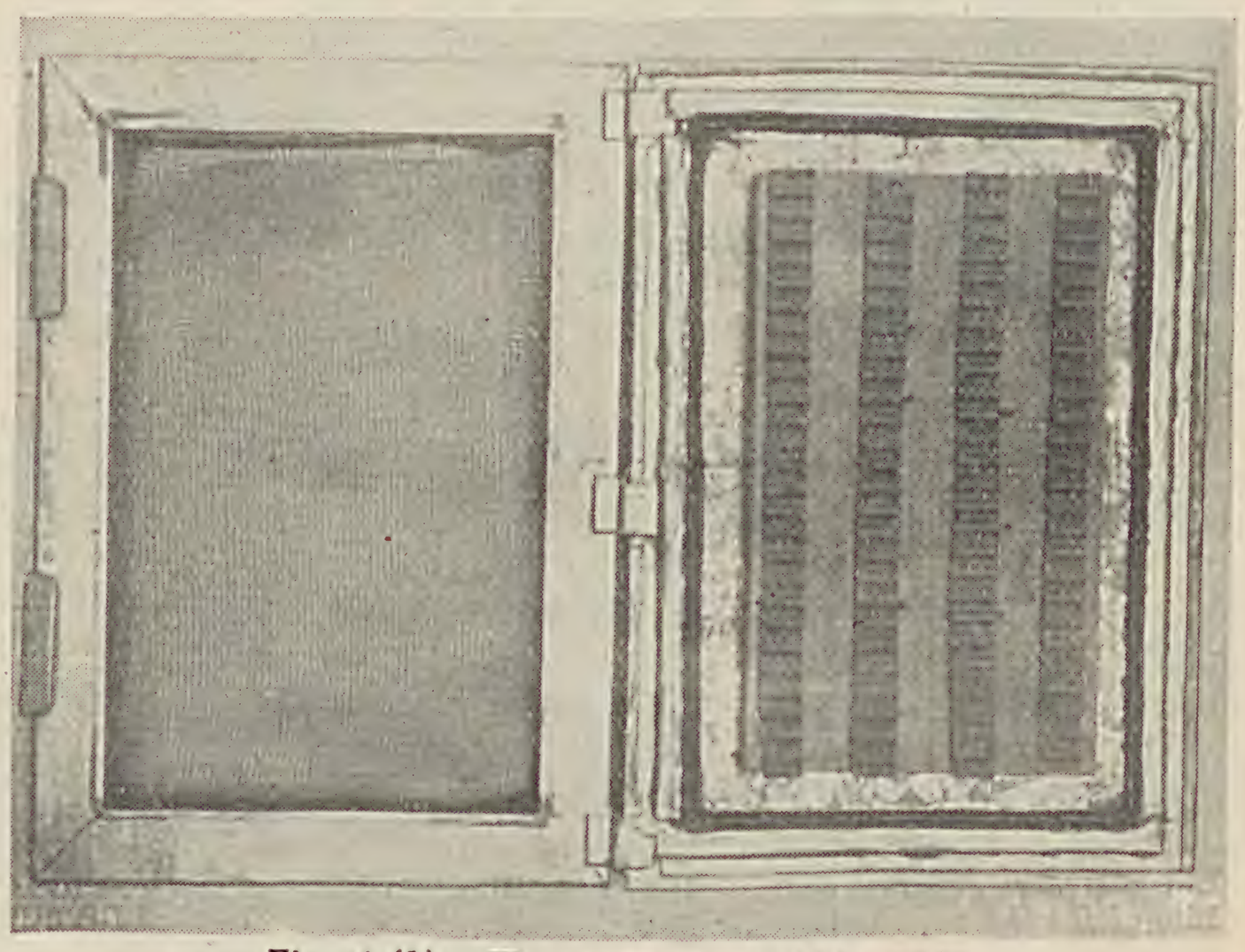
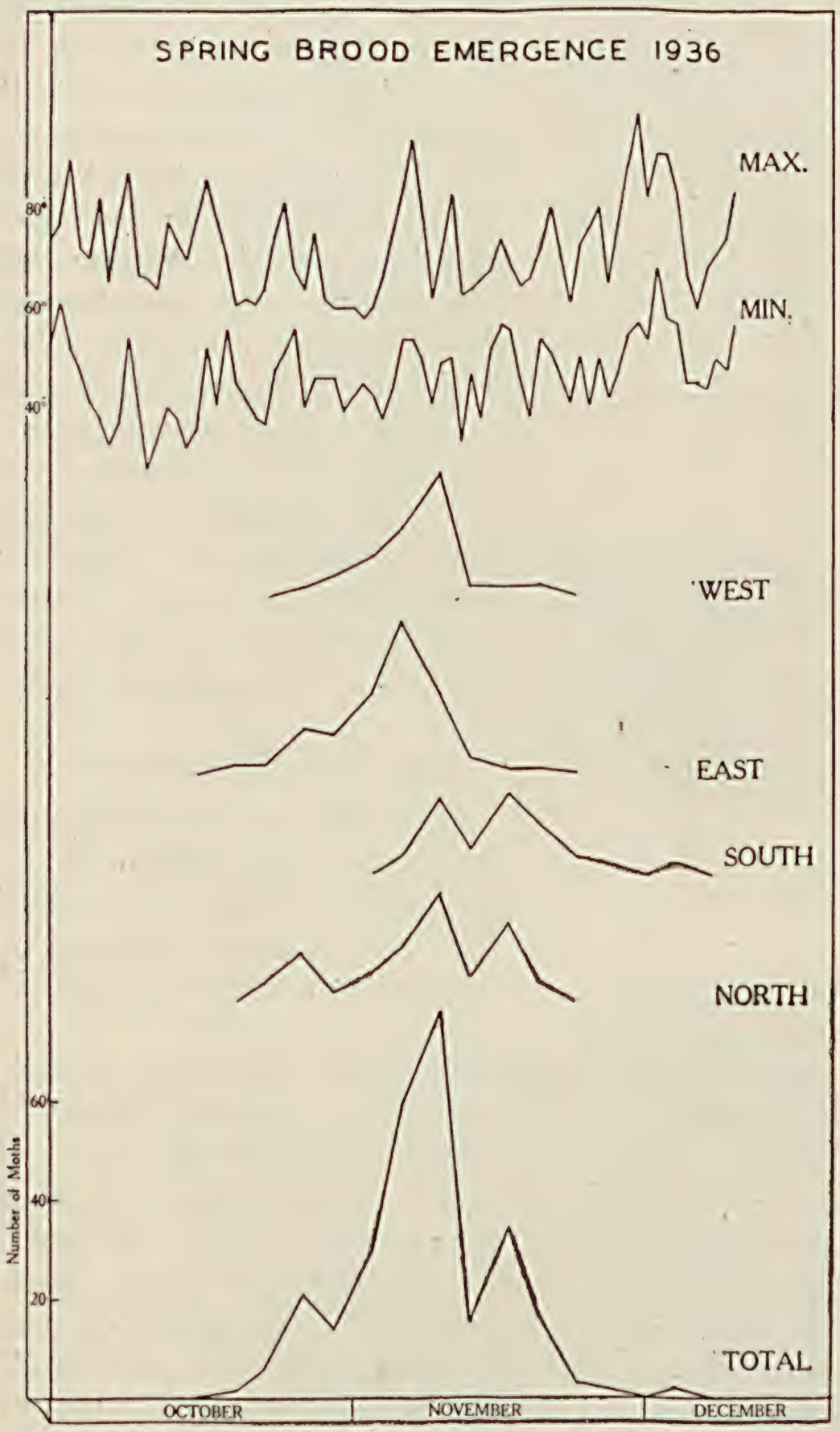


*Fig. 4 (b).—The emergence cage—open.*




***Graph 1.—Showing the moth emergences from field cages, together with the maximum and minimum temperatures for the period, Oct. to Dec., 1936.***

and environs of the tree, the larvae hibernating on the southern side of the tree emerging later than those on the other sides and thus extending the brood over a longer period than if all the larvae had hibernated on one side of the tree only.

It is also seen that the maximum total emergence corresponds very well with the peak of emergence obtained in the laboratory (see Table V.).

### *Codling Moth Activity.*

In order to have some guide as to the activity of the codling moths in the orchard during the season, lure records were taken throughout the experimental block. This was accomplished by placing 32 lure pots in the trees in the position shown on the accompanying plan of the plots. The lure pots were straight sided, glass containers capable of holding one pint of attractant liquid which, in these experiments, was a 10 per cent. vinegar solution. Fig. 5 illustrates the type of jar used. Records of the number of moths trapped in the lure pots were made twice a week, and plotted on a graph against maximum and minimum temperatures (see Graph 2). Such information was of great assistance in determining the correct time at which to apply the sprays in the various spray programmes.

In the early part of the season, considerable difficulty was experienced in the lure pots with the formation of a thick scum on the surface. This was obviated later by the addition to the solution of a very small quantity of copper sulphate solution.

From Graph 2 and from the records obtained in the laboratory it is deduced that there were two distinct broods of codling moths present in the orchard for the season 1936–37. The first moth of the spring brood was trapped in the lures on 12.10.36 and the last of this brood on 3.12.36, with a maximum period, not particularly distinct, but consisting of two peaks, one on 29.10.36, and the other on 5.11.36. The reason for the low number of moths trapped in the intervening period can be ascribed to the low daily maximum and minimum temperatures prevailing during that period.

The first moths of the first brood were trapped on 31.12.36, and the last on 1.3.37, with no definite maximum period of emergence. This brood appears to have been split up into two

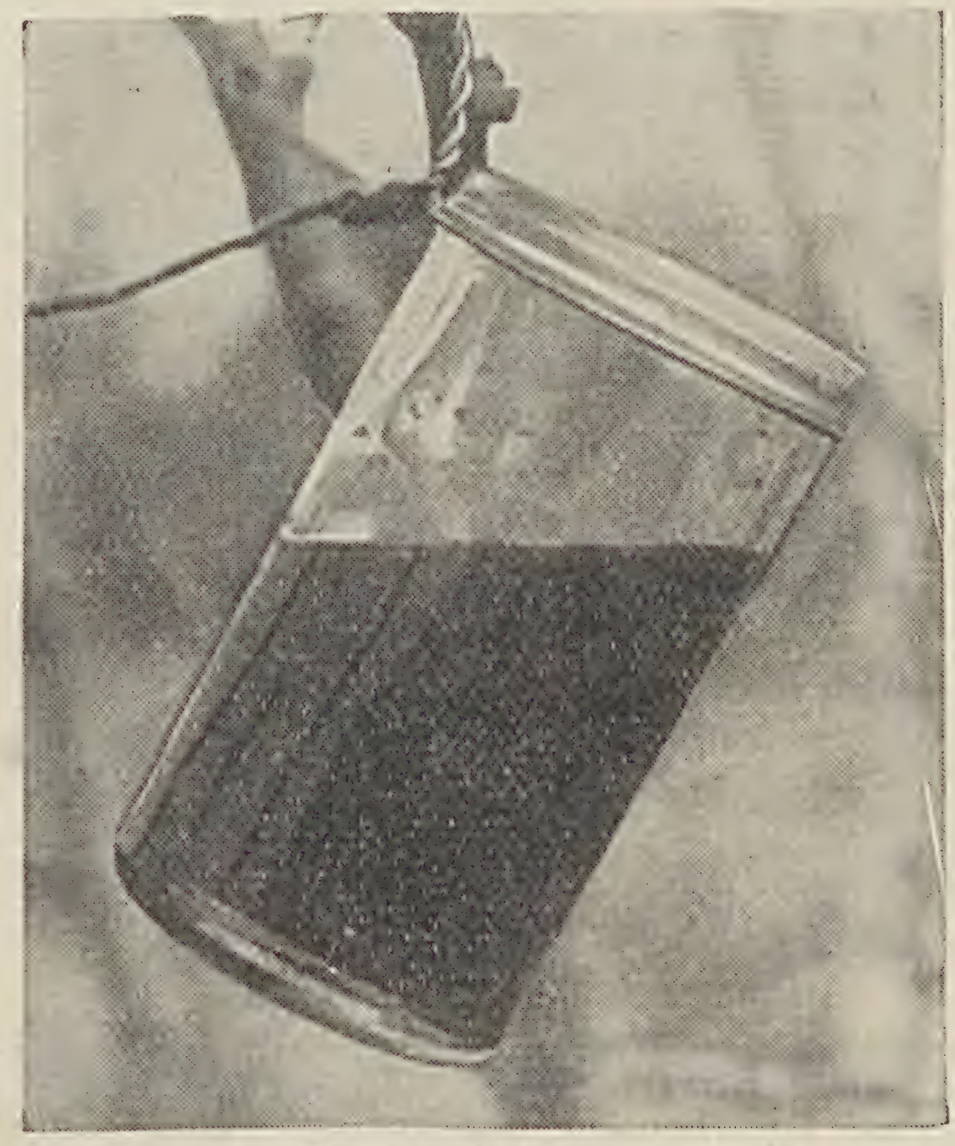
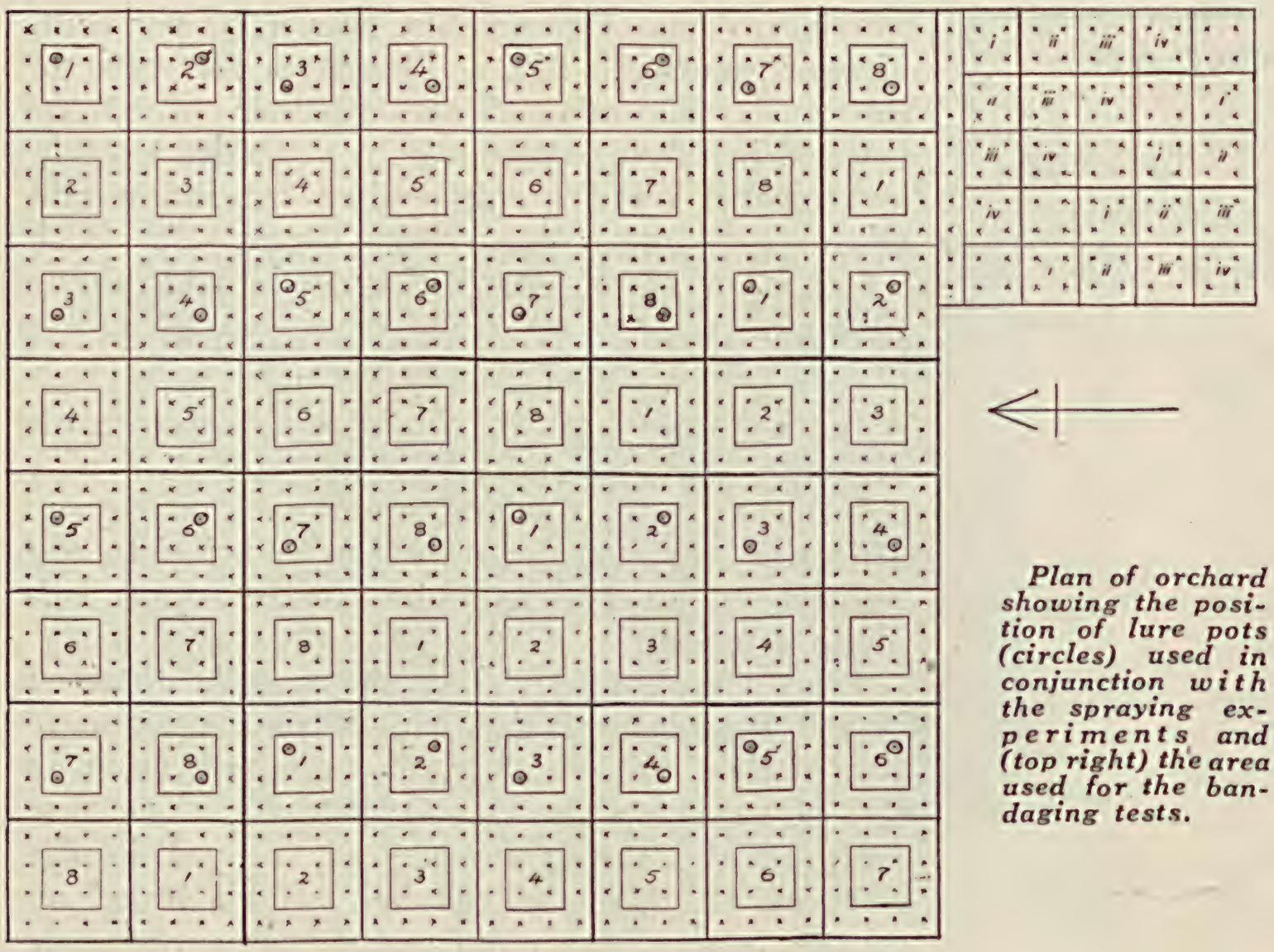


***Fig. 5.—A lure pot.***



*Plan of orchard showing the position of lure pots (circles) used in conjunction with the spraying experiments and (top right) the area used for the bandaging tests.*

main sections by relatively low temperatures which prevailed during the latter half of January, with the result that one small peak occurred on 14.1.37, and the larger peak on 18.2.37. On the experimental block the effect of this latter peak was not felt, as the fruit had been picked prior to this (9.3.37 to 13.3.37). It was in consequence of this late peak that growers in the district, who were forced to leave their fruit late on the trees, suffered through late entrances.

There was no evidence in the field of a further brood of moths as shown in the laboratory studies.

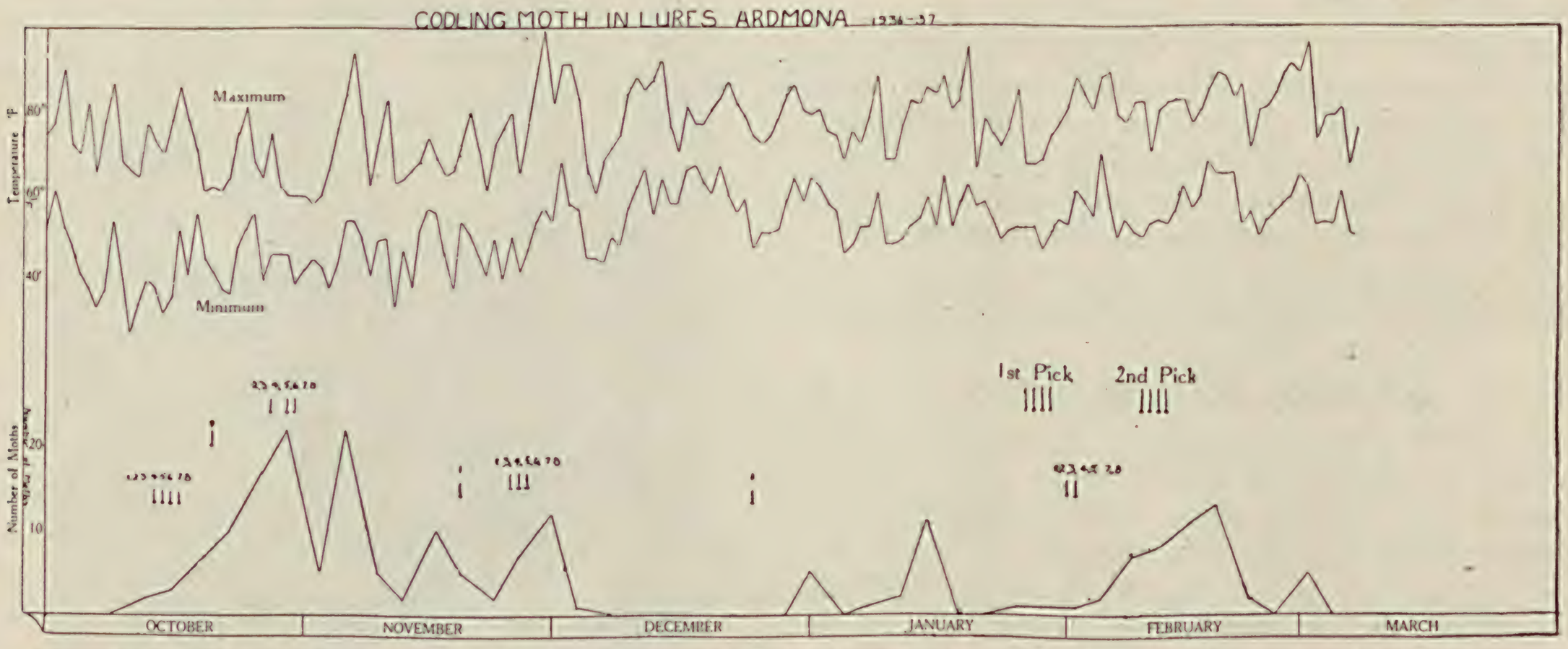
The catches of moths in the lures were used as indicators for the timing of sprays, e.g., for years it had been the practice of some growers in the area to apply an arsenate of lead spray during Christmas week, this being done without any reference whatever to the activities of the moths at that period. The lure records this season revealed that during December codling moth activity was at a minimum, and that an application of a spray during this period was unnecessary. Whether this will be the case in future seasons can be decided only by further experimental work.

## Control Experiments.

The control experiments, which were conducted on the property of Messrs. Turnbull Bros., Ardmona, consisted of two main parts—(*a*) Spraying in the field and (*b*) Bandaging tests.

**Spraying Experiments.**—As previously stated, these were carried out on a uniform block of Williams pear trees, approximately 26 years of age. The block of trees was in the form of a square, there being 32 trees in each of 32 rows. Eight different spray programmes were used, the plots being in the form of a Latin square (see plan). Each spray treatment was replicated eight times in the Latin square, each unit of treatment being a block of sixteen trees in a square.

At harvest time the fruit from the centre four trees only of each unit was used in computing the




***Graph 2.—Showing number of moths trapped in lure pots and the maximum and minimum temperatures at Ardmona 1936-37.***

percentage of codling moth infected fruit present. All of the fruit in each of the two pickings was hand sorted, no distinction being made between calyx entrances, side entrances, or stings. All applications of sprays were made at a pressure of approximately 300 lb. per square inch, rods being used for all sprays applied up to 27.11.36, any sprays after that date being applied with pistols.

The various spray programmes were devised to show the effect on codling moth control of—

(*a*) using spray programmes containing different strengths of arsenate of lead ;

(*b*) incorporating with standard acid arsenate of lead, spreaders of different types, e.g., a summer white spraying oil and a calcium caseinate spreader ;

(*c*) two spray programmes with identical cover spray applications, but one having two calyx sprays of arsenate of lead and the other three ;

(*d*) incorporating nicotine sulphate with acid arsenate of lead in the cover sprays only ;

(*e*) two spray programmes identical in all respects in early spray applications, but one having no cover spray between pickings of fruit, the other having a cover spray of arsenate of lead between pickings ;

(*f*) two spray programmes, one of which may be termed an average one for the Goulburn Valley, and the other, in which the spray applications of arsenate of lead were determined by means of lure records.

The following spray programmes were used, the times of application of each spray being given :—

*Programme No.* 1. (In each case the spray consisted of arsenate of lead paste 5 lb. to 80 gallons of water.)

| | |
|---|---|
| (*a*) Calyx spray .. .. | 13.10.36 |
| (*b*) First cover spray .. | 19.11.36 |
| (*c*) Second cover spray .. | 24.12.36 |
| (*d*) Third cover spray .. | 1.2.37 |

*Programme No.* 2. (5 lb. of lead arsenate paste to 80 gallons of water.)

| | |
|---|---|
| (*a*) First calyx spray .. | 13.10.36 |
| (*b*) Second calyx spray .. | 27.10.36 |
| (*c*) First cover spray .. | 25.11.36 |
| (*d*) Second cover spray .. | 1.2.37 |

*Programme No.* 3. (Arsenate of lead paste 8 lb. to 80 gallons of water.)

| | |
|---|---|
| (*a*) First calyx spray .. | 15.10.36 |
| (*b*) Second calyx spray .. | 29.10.36 |
| (*c*) First cover spray .. | 26.11.36 |
| (*d*) Second cover spray .. | 2.2.37 |

*Programme No.* 4. (In this case the spray consisted of 5 lb. arsenate of lead paste, plus 1 lb. calcium caseinate spreader to 80 gallons of water.)

| | |
|---|---|
| (*a*) First calyx spray .. | 16.10.36 |
| (*b*) Second calyx spray .. | 30.10.36 |
| (*c*) First cover spray .. | 27.11.36 |
| (*d*) Second cover spray .. | 2.2.37 |

*Programme No.* 5. (5 lb. lead arsenate paste, plus 1 pint of summer white oil to 80 gallons of water.)

| | |
|---|---|
| (*a*) First calyx spray .. | 16.10.36 |
| (*b*) Second calyx spray .. | 30.10.36 |
| (*c*) First cover spray .. | 27.11.36 |
| (*d*) Second cover spray .. | 2.2.37 |

*Programme No.* 6. (Arsenate of lead paste 5 lb. to 80 gallons of water.)

| | |
|---|---|
| (*a*) First calyx spray .. | 13.10.36 |
| (*b*) Second calyx spray .. | 27.10.36 |
| (*c*) First cover spray .. | 25.11.36 |

*Programme No.* 7. (Arsenate of lead paste 5 lb. to 80 gallons of water.)

| | |
|---|---|
| (*a*) First calyx spray .. | 13.10.36 |
| (*b*) Second calyx spray .. | 20.10.36 |
| (*c*) Third calyx spray .. | 27.10.36 |
| (*d*) First cover spray .. | 25.11.36 |
| (*e*) Second cover spray .. | 2.2.37 |

*Programme No.* 8. (The calyx sprays consisted of 5 lb. of lead arsenate to 80 gallons of water, while in the case of the cover sprays 1 pint of nicotine sulphate was applied in addition to the lead arsenate.)

| | |
|---|---|
| (*a*) First calyx spray .. | 13.10.36 |
| (*b*) Second calyx spray .. | 27.10.36 |
| (*c*) First cover spray .. | 27.11.36 |
| (*d*) Second cover spray .. | 2.2.37 |

The analyses of the spray materials used in the above programmes are as follows :—

| | % |
|---|---|
| *Arsenate of lead paste*— | |
| Moisture .. .. .. | 49·27 |
| Total arsenic pentoxide ($As_2O_5$) .. | 32·65 |
| Water soluble arsenic pentoxide ($As_2O_5$) .. .. .. | 0·11 |
| *Nicotine sulphate*— | |
| Nicotine .. .. .. | 40·77 |
| *White spraying oil*— | |
| Water .. .. .. | 15·7 |
| Oil .. .. .. .. | 81·9 |
| Emulsifier (difference) .. .. | 2·4 |
| *Calcium caseinate spreader*— | |
| Nitrogen .. .. .. | 2·3 |
| Equivalent to casein .. .. | 14·6 |
| Lime (CaO) .. .. .. | 49.6 |

The harvesting of the fruit from the various sections took place in two pickings, the first period being from 26th January to 29th January

inclusive, while the second was from 9th February to 13th February inclusive. The percentages of codling moth infested fruit are set out in detail in Table VII.

TABLE VII.—PERCENTAGE OF CODLING MOTH INFESTED FRUIT FOR EACH UNIT OF TREATMENT OF SPRAY BLOCK, 1936–37. (THE SPRAY PROGRAMME USED IS INDICATED IN BRACKETS.)

**Packing Shed.**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 24·21 (1) | 13·76 (2) | 10·86 (3) | 15·97 (4) | 10·19 (5) | 8·97 (6) | 8·19 (7) | 7·12 (8) |
| 8·28 (2) | 5·93 (3) | 14·54 (4) | 12·04 (5) | 9·77 (6) | 10·45 (7) | 11·45 (8) | 8·85 (1) |
| 11·83 (3) | 10·32 (4) | 7·78 (5) | 12·43 (6) | 5·85 (7) | 7·13 (8) | 7·93 (1) | 7·67 (2) |
| 13·73 (4) | 8·07 (5) | 7·19 (6) | 4·44 (7) | 7·30 (8) | 5·60 (1) | 4·88 (2) | 2·96 (3) |
| 5·21 (5) | 8·55 (6) | 5·71 (7) | 8·25 (8) | 3·69 (1) | 5·97 (2) | 2·93 (3) | 11·34 (4) |
| 5·07 (6) | 5·11 (7) | 5·70 (8) | 6·39 (1) | 3·55 (2) | 2·31 (3) | 4·16 (4) | 1·97 (5) |
| 4·08 (7) | 7·32 (8) | 10·60 (1) | 8·67 (2) | 3·15 (3) | 11·13 (4) | 6·01 (5) | 10·44 (6) |
| 6·75 (8) | 8·36 (1) | 6·65 (2) | 3·97 (3) | 7·62 (4) | 6·26 (5) | 5·48 (6) | 3·39 (7) |

Statistical examination of the figures shown in Table VII. reveals the information set out in Table VIII.

TABLE VIII.—SHOWING STATISTICAL EXAMINATION OF CODLING MOTH PERCENTAGE FIGURES.

*Analysis of Variance.*

| Due to— | Degrees of Freedom. | Sum of Squares. | Mean Square. |
|---|---|---|---|
| Rows .. .. | 7 | 349·2340 | |
| Columns .. | 7 | 103·0992 | |
| Treatment .. | 7 | 193·8314 | 27·6902 |
| Error .. .. | 42 | 261·8502 | 6·2345 |
| Total .. | 63 | 908·0148 | |

$$\text{Standard error} = \sqrt{\frac{6 \cdot 2345}{8}} = 0 \cdot 882$$

$$\frac{\text{Significant difference}}{F \text{ value of experiment (actual)}} = \frac{2 \cdot 47 \text{ per cent.}}{4 \cdot 44}$$

$F$ 1% value of experiment = 3·1

On averaging the figures quoted in Table VII., the percentage of codling moth infested fruit for each of the above spray programmes is obtained.

Programme No. 1, 9·45 per cent.
,, No. 2, 7·43 per cent.
,, No. 3, 5·49 per cent.
,, No. 4, 11·10 per cent.
,, No. 5, 7·19 per cent.
,, No. 6, 8·49 per cent.
,, No. 7, 5.65 per cent.
,, No. 8, 7·63 per cent.

From a study of these figures in conjunction with the figure obtained for significant differences in Table VIII., the following points are brought out :—

(*a*) There was no significant difference in control obtained by the use of a heavier dosage of lead arsenate paste ; 8 lb. as compared with 5 lb. in 80 gallons of water, used as two calyx and two cover sprays. (Programmes Nos. 2 and 3.)

(*b*) There was no significant difference in control obtained when 1 pint of summer white spraying oil was used in addition to 5 lb. lead arsenate paste to 80 gallons of water and applied as two calyx and two cover sprays. There was, however, a significantly poorer control of codling moth obtained when the spray programme consisted of two calyx and two cover sprays of 5 lb. of arsenate of lead paste, plus 1 lb. of calcium caseinate spreader in 80 gallons of water, as compared with lead arsenate alone and lead arsenate, plus summer white spraying oil. (Programmes Nos. 2, 4, and 5.)

(*c*) There was no significant difference in control obtained where a spray programme consisting of two calyx and two cover sprays of arsenate of lead paste (5 lb. to 80 gallons of water) was compared with one containing three calyx and two cover sprays of arsenate of lead paste. (Programmes Nos. 2 and 7.)

(*d*) There was no significant difference in control obtained when 1 pint of nicotine sulphate was applied, in addition to the arsenate of lead paste (5 lb. to 80 gallons), as two calyx and two cover sprays. (Programmes Nos. 2 and 8.)

(*e*) There was no significant difference in control obtained by the omission of the final cover spray from a programme consisting of two calyx and two cover sprays of arsenate of lead paste, 5 lb. to 80 gallons of water. (Programmes Nos. 2 and 6.)

(*f*) When the so-called average Goulburn Valley spray programme (No. 1) is compared with all other programmes, significant differences in improved control are evident in two only, viz., programme No. 3, consisting of two calyx and two cover sprays of arsenate of lead paste 8 lb. to 80 gallons of water, and in programme No. 7, consisting of three calyx sprays and two cover sprays of arsenate of lead paste 5 lb. to 80 gallons of water. (Programmes Nos. 1 to 8.)

A very interesting point is brought out from a study of the codling moth infection as shown in Table VII. It will be noticed that the percentage of codling moth is very high in the vicinity of the packing shed, its influence really extending over a radius of about sixteen trees. The danger of codling moth infection from such a source has been realized by orchardists for many years, and the above serves as an excellent example of this point.

**Bandaging Experiment.**—In a block of 80 Williams pear trees immediately adjacent to the spraying block, experiments were conducted to discover the efficacy of four types of bandages as supplementary aids to spraying. The four types used were as follows :—

(i) Corrugated cardboard bandage chemically treated—impregnated with Beta naphthol,
(ii) corrugated cardboard bandage untreated,
(iii) hessian bandage, and
(iv) a combined bandage consisting of one half of corrugated cardboard untreated and the other half of corrugated cardboard chemically treated.

These plots were laid out in the form of a randomized block, each treatment being replicated five times, the unit of treatment being four trees. The bandage in sections (ii), (iii), and one half of (iv) were removed every week and the codling moth larvae present recorded, but the bandage in section (i) and the other half of section (iv) remained on the trees until the end of the season, when they were removed and the number of larvae present determined.

The counts of larvae obtained for each of the four treatments are set out in Table IX.

TABLE IX.—NUMBER OF LARVAE TRAPPED PER PLOT IN THE BANDAGING EXPERIMENTS.

| Chemically Treated Bandage. | Untreated Bandage. | Hessian Bandage. | Combined Bandage. |
|---|---|---|---|
| 17 | 1 | 29 | 7 |
| 11 | 3 | 30 | 5 |
| 10 | 5 | 48 | 10 |
| 16 | 7 | 49 | 9 |
| 17 | 8 | 47 | 7 |

On examining statistically the figures in Table IX. the results shown in Table X. are obtained.

TABLE X.—STATISTICAL EXAMINATION OF BANDAGING EXPERIMENTS.

*Analysis of Variance.*

| Due to— | Degrees of Freedom. | Sum of Squares. | Mean Squares. |
|---|---|---|---|
| Blocks .. .. | 3 | 217·2 | |
| Treatments .. | 4 | 4009·2 | 1002·3 |
| Error .. .. | 12 | 290·8 | 24·23 |
| Total .. | 19 | 4517·2 | |

$$\text{Standard error} = \sqrt{\frac{24 \cdot 23}{5}} = 2 \cdot 20$$

$$\frac{\text{Significant difference}}{F \text{ value of experiment (actual)}} = \frac{6 \cdot 16}{41 \cdot 36}$$

$F$ 1% value of experiment = 3·26

On averaging the figures quoted in Table IX., the following numbers of codling moth larvae per plot are obtained for each of the treatments :—

Chemically treated bandage .. 14·2 larvae
Untreated bandage .. 4·8 ,,
Hessian bandage .. .. 40·6 ,,
Combined bandage .. .. 7·6 ,,

It is seen from a study of these figures, together with the significant difference figure of 6·16 shown in Table X., that there is—

(*a*) A significantly poor catch of larvae in the chemically treated corrugated bandages when compared with the catch of larvae in the hessian bandages. (Treatments (i) and (iii)).

(*b*) A significantly poor catch of larvae in both the untreated corrugated bandages

and the composite bandages when compared with the chemically treated corrugated bandage. (Treatments (i), (ii), and (iv)).

With regard to the first statement the fact that 76·05 per cent. of the larvae captured in the chemically treated corrugated bandages were destroyed by the toxic action of the bandage must be taken into account. In the case of hessian bandages, it would be necessary to examine the bandages weekly and destroy all larvae found present.

It is of interest to note the number of larvae trapped in the chemically treated section of the combined bandage and compare it with the number trapped in the untreated section. To obviate, as far as possible, any errors due to the relative position of these components on the trunk of the tree, in each unit of four trees, the position of the components were varied according to the point of the compass, as shown in the accompanying diagram.

The same relative positions were observed in each unit throughout the block.

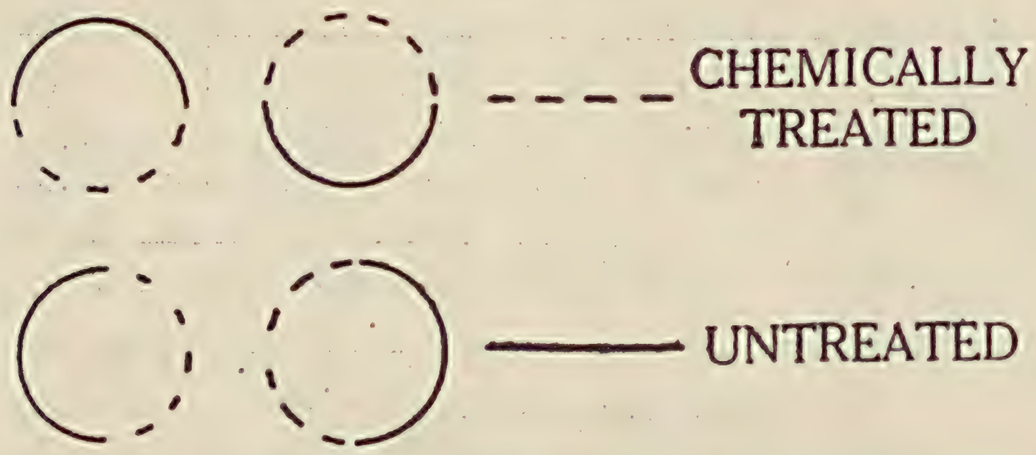



Table XI. sets out the catch of larvae in each of the components of the composite bandage.

TABLE XI.—NUMBER OF LARVAE TRAPPED IN THE COMPONENTS OF THE COMPOSITE BANDAGES, 1936–37.

| — | Untreated Section. | Chemically Treated Section. |
|---|---|---|
| Replicate 1 .. .. | 1 | 6 |
| 2 .. .. | 0 | 5 |
| 3 .. .. | 2 | 8 |
| 4 .. .. | 2 | 7 |
| 5 .. .. | 2 | 5 |
| Average .. .. | 1·4 | 6·2 |

On examining these figures statistically the information shown in Table XII. is obtained.

It is seen from a study of the figures shown in Table XI., together with the significant difference of approximately 1 from Table XII., that there was a significantly poor catch of larvae in the untreated corrugated component compared with the chemically treated one. This bears out the general results obtained in the main bandaging experiment.

TABLE XII.—STATISTICAL EXAMINATION OF COMPOSITE BANDAGING EXPERIMENTS.

*Analysis of Variance.*

| Due to— | Degrees of Freedom. | Sum of Squares. | Mean Squares. |
|---|---|---|---|
| Blocks .. .. | 4 | 7·6 | |
| Treatments .. | 1 | 57·6 | 57·6 |
| Error .. .. | 4 | 2·4 | 0·6 |
| Total .. | 9 | 67·6 | |

$$\text{Standard error} = \sqrt{\frac{0\cdot6}{5}} = 0\cdot346$$

$$\frac{\text{Significant difference}}{F \text{ value of experiment}} = \frac{0\cdot97}{96\cdot0}$$

$F$ 1% value of experiment = 7·71

## *Arsenical Residues.*

*On Fruit.*—In order to determine the arsenical residue on the fruit at picking time from the various spray schedules, samples of twenty pears were taken from each of the units of the spraying block at the time of the first pick, and submitted to the Agricultural Research Chemist for arsenic determination. The results of these analyses are shown in Table XIII.

In Table XIV. is set out the statistical analysis of the figures from Table XIII.

On averaging the figures, for arsenic residue, quoted in Table XIII., the following figures (grains $As_2O_3$ per lb. of fruit) are obtained for each of the spray schedules:—

Programme No. 1, 0·015
,, No. 2, 0·0135
,, No. 3, 0·016
,, No. 4, 0·009
,, No. 5, 0·011
,, No. 6, 0·009
,, No. 7, 0·0125
,, No. 8, 0·009.

From these figures, it is seen that three of the programmes have arsenic ($As_2O_3$) residues, at the time of the first pick, below the prescribed limit of 0·01 grains per lb. of fruit, i.e., Programmes Nos. 4, 6, and 8. However, Programmes Nos. 4 and 8 received a further arsenical spray between the time of the first picking and the second picking. It is, therefore, reasonable to assume

TABLE XIII.—ARSENIC RESIDUE FIGURES AT THE TIME OF THE FIRST PICK FROM EACH UNIT OF TREATMENT OF THE SPRAYING BLOCK, ARDMONA, 1936–37.

(Grains of $As_2O_3$ per lb. of Fruit.)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ·016 | ·014 | ·013 | ·011 | ·009 | ·012 | ·014 | ·008 |
| ·009 | ·015 | ·008 | ·013 | ·007 | ·014 | ·005 | ·013 |
| ·018 | ·007 | ·010 | ·009 | ·011 | ·008 | ·016 | ·013 |
| ·008 | ·009 | ·008 | ·010 | ·010 | ·014 | ·013 | ·018 |
| ·015 | ·012 | ·016 | ·011 | ·011 | ·014 | ·017 | ·008 |
| ·009 | ·012 | ·009 | ·019 | ·013 | ·013 | ·010 | ·013 |
| ·010 | ·009 | .012 | ·012 | ·014 | ·007 | ·008 | ·006 |
| ·012 | ·021 | ·020 | ·018 | ·013 | ·012 | ·012 | ·013 |

TABLE XIV.—STATISTICAL ANALYSIS OF THE ARSENIC RESIDUE FIGURES ON FRUIT, ARDMONA, 1936–37.

*Analysis of Variance.*

| Due to— | Degrees of Freedom. | Sum of Squares. | Mean Square. |
|---|---|---|---|
| Rows .. .. | 7 | ·000152 | |
| Columns .. .. | 7 | ·000018 | |
| Treatments .. | 7 | ·000422 | ·00006029 |
| Error .. .. | 42 | ·000194 | ·00000462 |
| Total ... | 63 | ·000786 | |

$$\text{Standard error} = \sqrt{\frac{\cdot 00000462}{8}}$$

$$= 0\cdot 00076.$$

Significant difference $= 0\cdot 002.$

*F* value of experiment (actual) 13·05

*F* 1 per cent. value of experiment 3·1 (approx.)

that Programme No. 6, which consists of three sprays alone, would be the only one, at the time of the second pick, which would conform to the limit prescribed by law.

It is very hard to understand why the arsenic residue in Programme No. 2 should be so much higher than that of Programme No. 6, which received exactly similar sprays, or that of Programme No. 8, which was identical with Programme No. 2, except for the addition of nicotine sulphate

Combining these average figures with that obtained for significant differences in Table XIV. the following information is obtained :—

(*a*) There is a significant increase in the amount of arsenic residue where a spray programme consisting of three sprays of arsenate of lead paste 8 lb. to 80 gallons of water is compared with a spray programme consisting of three sprays of arsenate of lead paste 5 lb. to 80 gallons of water. (Programmes Nos. 2 and 3.)

(*b*) There is a significant reduction in the amount of arsenic residue where both spray programmes containing spreaders with the arsenate of lead are compared with the spray programme containing arsenate of lead without spreader. (Programmes Nos. 2, 4, and 5.)

(*c*) There is a significant reduction in the amount of arsenic residue where the spray programme consisting of three sprays of arsenate of lead, plus nicotine sulphate is compared with the comparable spray programme consisting of three sprays of arsenate of lead alone. (Programmes Nos. 2 and 8.)

(*d*) There is no significant difference in the amount of arsenic residue when the spray programme consisting of two calyx and one cover sprays of arsenate of lead is compared with the spray programme consisting of three calyx and one cover sprays of arsenate of lead. (Programmes Nos. 2 and 7.)

It is deduced, therefore, that the greatest amount of arsenic present on the fruit at picking time comes from the sprayings later in the season, and not from the initial sprayings.

*On Foliage.*—In order to study the variation in the amount of arsenic per unit of surface as a result of the various spray programmes, it was decided to sample leaves from the various sections at regular intervals, and obtain the total arsenic content of these samples. For this purpose, samples of 100 leaves were taken from the different spray programmes immediately prior to, and after each spraying, as soon as the foliage had dried. These were forwarded to the Agricultural Research Chemist for analysis. In addition, at each sampling, a further 100 leaves were taken and their area was determined by means of a planimeter.

A study of the figures obtained revealed no uniformity. In fact, there was a general reversal of results in some cases which could not be accounted for. Therefore, no attempt will be made to draw conclusions from this aspect of the work.

## *Parasites and Predators.*

During the course of the investigation, one predator and two parasites were observed.

On collecting larvae from hessian bandages at the base of pear trees, several specimens of a Carab, *Laemostenus complanatus* Dejean, were observed feeding rather voraciously on codling moth larvae. This is an introduced species of Carab, said by Horn (1) to be spread rather widely over the globe by commerce. The species of Carab described by Blackburn under the name of *Pristonychus australis* Blackburn, is considered to be identical with Dejean's species above (2).

In laboratory studies of material collected in the field, two species of Chalcid wasps were bred. One, *Chalcis victoria Gir var noctia Gir.*, was a larval parasite, while the other, *Pseudanoganus stironutus* Cameron, was a pupal parasite. This latter species is rather similar in appearance to *Dibrachys australis Gir.*, the well known larval parasite of the Oriental Peach Moth (*Cydia molesta* Busck).

Owing to very limited emergences of these parasites it was not possible to carry out any parasitic studies.

### Other Insects Bred.

Clapp's Favourite pears, from the Toolamba district, yielded larvae from which the oriental peach moth (*Cydia molesta* Busck) was bred. This is a most important point as it constitutes the first record from Victoria of this insect being taken from pears in the field.

## *Summary.*

The codling moth (*Cydia pomonella L.*) was in evidence in the Goulburn Valley attacking pears during the season 1936–37. On the experimental plot at Ardmona, the infestation ranged from a minimum of 5·49 per cent. to a maximum of 11·10 per cent. according to the programme under consideration. The average infestation over the whole block of more than 1,000 trees was approximately 8 per cent.

Life history studies conducted in the laboratory showed that there were two distinct broods present during the season, with a very small third brood of moths late in the season. Of the larvae of the first brood, 7·14 per cent. over wintered, and of the second brood 87·72 per cent. of the larvae over wintered.

In the field, two distinct broods of codling moths were present. The first moths of the spring brood were trapped in lures on 12th October, 1936, and the last on 3rd December, 1936, with two peak periods occurring on 29th October, 1936, and 5th November, 1936, the reason for this prolonging of the peak period being found in low temperatures prevailing at the beginning of November. The first moths of the first brood were trapped on 31st December, 1936, and the last on 1st March, 1937, with no definite peak period.

In the spraying experiments in the field, eight different spray programmes were used, the minimum codling moth infestation of 5·49 per cent. being obtained with a spray programme consisting of two calyx and two cover sprays of arsenate of lead, 8 lb. to 80 gallons of water. However, there was no significant difference in the control observed with this programme, and with one of the same number of sprays of arsenate of lead, 5 lb. to 80 gallons of water.

Field experiments were conducted with four different methods of bandaging the trunks of the trees. Of these, the normal "bag" or hessian bandage trapped the largest number of larvae, there being an average of 10·1 per bandage. The chemically treated corrugated bandages trapped only 3·55 larvae per bandage, this reduction from the hessian bandage figure being significant. Of the larvae trapped in the chemically treated bandages 76 per cent. were dead.

Of the eight spray programmes used in the field, three only gave an arsenic residue on the fruit, at the time of the first pick, below the limit prescribed by law. It can be assumed that one only of these programmes would conform to this limit at the time of the second pick, i.e., the programme consisting of two calyx and one cover spray of arsenate of lead 5 lb. to 80 gallons of water.

One larval parasite, one pupal parasite, and one predator of the codling moth were observed during the progress of the work.

The oriental peach moth (*Cydia molesta* Busck) was recorded for the first time in Victoria attacking pears in the field.

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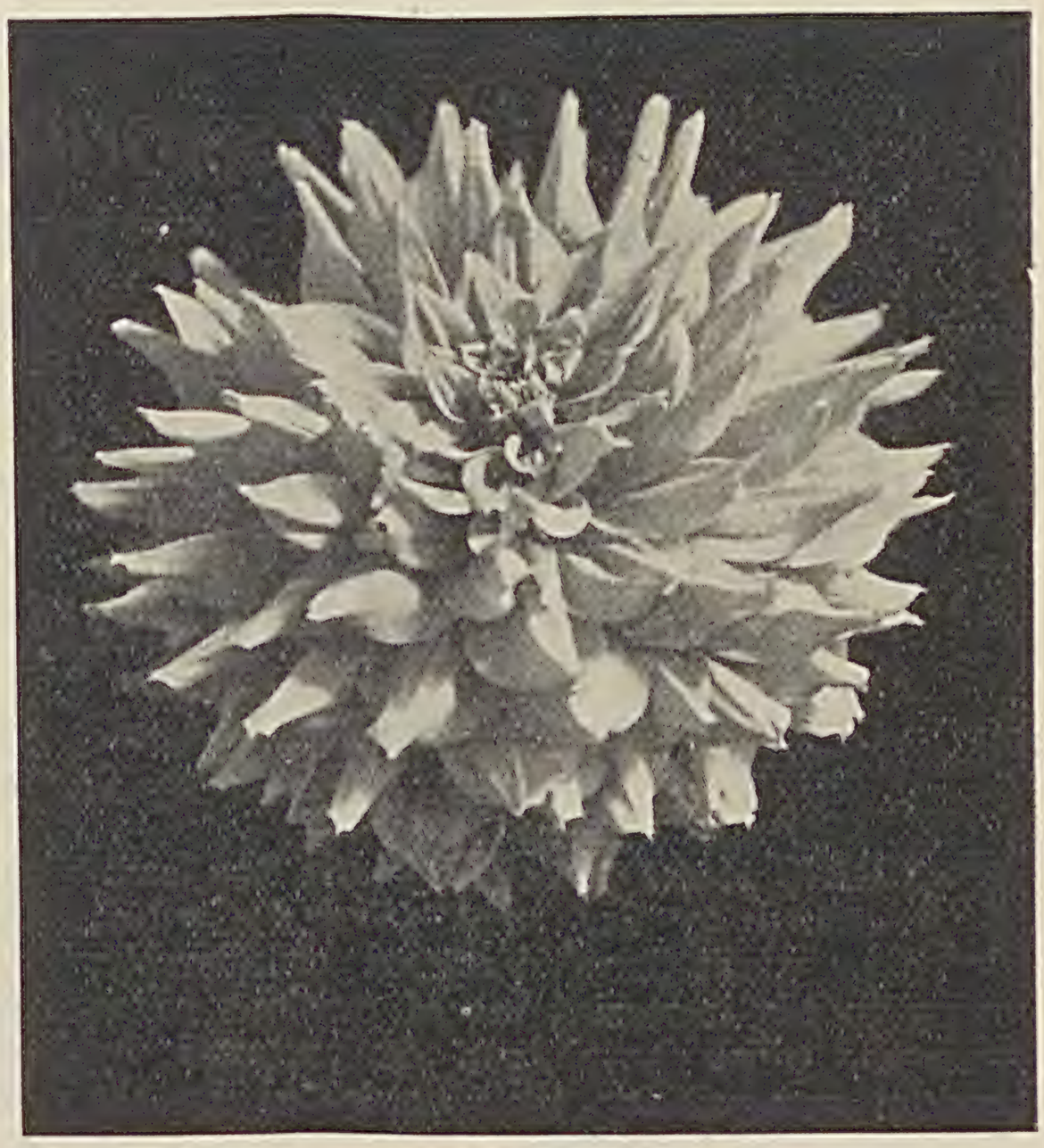
# Orchard and Garden Notes

*By Edward E. Pescott, F.L.S*



*A decorative dahlia—Marie Rose.*

### The Flower Garden.

CONSIDERATION must now be given to planting Dahlias. If early blooms are desired, the tubers should be planted now: if late flowers are required, then planting can be delayed for five or six weeks. Dahlias will give satisfactory results only if the soil has been well cultivated and well manured. It is not yet too late to sow a crop to be used as green manure for a late planting. The best plant to sow now is mustard; the seed quickly germinates, and in six weeks will be fit to be dug in.

In any case it is wise to dig some humus, in the form of manure, into the beds before planting. If manure be not available, then leaf mould or garden litter should be used; it will be all the better for a sprinkling of bone dust or bone meal.

The bunch or clump of tubers should be cut up so that there is at least one shoot on each piece. The position of the tuber in the soil is immaterial. It may be placed at any angle, but the bud must point upwards. Further, it is wise to drive the stake (that will be required as a support later), before planting and so avoid the risk of injuring the tuber after the shoot has appeared.

### The Kitchen Garden.

Tomato plants may be set out in beds that have been previously manured. There are many tomato varieties now grown, and often gardeners take just what varieties the nurseryman hands them. It is the policy of this Department, as far as possible, to eliminate all rough and corrugated varieties, and substitute round and perfectly smooth types. They are more satisfactory to grow, and especially to pack.

Among the best varieties are Eccles Surprise and Red Marhio, which yield heavy crops of good quality. In the home garden they should be staked. Recruit and Market King are among the very fair varieties. They produce good clusters of fruit, somewhat small perhaps and rather watery.

San Mazano is a variety only suited for sauce, for which it is largely grown. It is far too dry and flavourless for table or for ordinary culinary purposes. The fruit which carries well, should not be gathered until it is quite red.

All tomatoes must be well fed and watered, if a good crop is to be gathered.

### The Orchard.

The fight against codling moth is again beginning. It is imperative that orchardists should have lure pots hung in the orchard in order to observe the time of the emergence and the flight of the moths. The old haphazard method of spraying at petal fall, and at regular fortnightly intervals subsequently, is now known to be quite useless. Indeed, it is dangerous. By the old rule of thumb method, sprays were put on which were quite unnecessary and inoperative.

[*Continued on page* 520.

# Professional Papers

[This section is devoted to professional papers and articles of a scientific character.]

# The Reactions of Wheat Varieties to Flag Smut

*By C. R. Millikan, M.Agr.Sc., Assistant Plant Pathologist, and*
*H. J. Sims, B.Agr.Sc., Science Field Officer.*

DURING recent years in Victoria, the losses caused by flag smut (*Urocystis tritici*) in wheat have decreased considerably, owing to the increasing use of resistant wheat varieties, which have been demonstrated by varietal susceptibility trials conducted by the Department of Agriculture.

Previous results (1) showed Ghurka to be the most satisfactory resistant variety for general sowing in Victoria, and its increasing popularity has been due to its high yielding ability as well as to its resistance to flag smut. The breeding of new crossbred wheats with the object of producing a variety even more prolific and highly resistant to flag smut than Ghurka is in progress in Victoria. The work of classifying wheat varieties and those new crossbreds possessing other desirable agricultural characteristics, in accordance with their susceptibility to flag smut, has been continued, and the results of these varietal susceptibility trials, from 1931 to 1936 inclusive, are shown in Table I.

During the period 1931 to 1933 the trials were conducted at six centres distributed over the Victorian wheat area (1), but since that time the work has been confined to the Mallee Research Station, Walpeup, as it has been found that consistently high infections result from early sowings at this centre. The inoculation of all seed for these experiments was performed at the Plant Research Laboratory, Burnley. The grains for these tests were shaken up with excess of spore material, which was removed after inoculation by means of a 2 m.m. sieve, before packeting the seed. This method was found to give the most uniform inoculation for small quantities of seed. In yield experiments, where much larger quantities of inoculated seed were required, the grain and spore material were carefully weighed before inoculation.

The susceptible variety Free Gallipoli has been used throughout these trials as the basis of comparison of the susceptibilities of the varieties and crossbreds. Check rows of Free Gallipoli were sown every fifth row throughout the tests, and all results were calculated on a basis of Free Gallipoli = 100 per cent. infection.

The difficulties of satisfactorily classifying wheat varieties as regards their susceptibility to flag smut have been previously described (1). As it was found that the inherent resistance of wheat varieties is not as great as the apparent resistance exhibited under conditions where the risk of infection is low, the results of all tests in which less than 35 per cent. infection occurred in Free Gallipoli check rows, were discarded. Actually the average percentage infection of the Free Gallipoli check rows in all the experiments represented by Table I. was 62 per cent.

In spite of this precaution it was found that the error in this type of experiment is extremely large. The accuracy of the results are obviously dependent upon the number of determinations included in the average, as indicated by the standard errors shown in Table I. As it was apparent that the variance of the results in the susceptible group (susceptibility figures 50 or over) was greater than that of the resistant groups (susceptibility figures less than 50), standard errors were calculated for each group separately. This was done by selecting sixteen susceptible and ten resistant varieties for which ten or more separate results were available, and calculating analyses of variance. It was assumed that the variance of the other varieties and crossbreds from each group would be similar.

TABLE I.—FLAG SMUT INVESTIGATIONS, 1931 TO 1936. RESULTS OF VARIETAL SUSCEPTIBILITY TRIALS SHOWING THE SUSCEPTIBILITY FIGURES OBTAINED, BASED ON FREE GALLIPOLI = 100 PER CENT. INFECTION.

*Note.*—The actual average percentage infection of Free Gallipoli in all experiments = 62 per cent.

| Variety. | Susceptibility Figure. | No. of Results in Average. | | Variety. | Susceptibility Figure. | No. of Results in Average. | |
|---|---|---|---|---|---|---|---|
| Sepoy Seln. (Walpeup) .. | 127 | 1 | | Early Bird .. .. | 89 | 2 | |
| Indian H. .. .. | 127 | 11 | | Ranee × Gallipoli (W 5806, J 3–2–1) .. .. | 89 | 7 | |
| Amity .. .. | 123 | 2 | | Major × Ranee (W 4020, K 12–1–4–1) .. .. | 89 | 2 | |
| Genoa .. .. .. | 122 | 2 | | Major × Ranee (W 4020, K 12–1–2–1) .. .. | 89 | 2 | |
| Canberra .. .. | 121 | 3 | | Yandilla King × Penny (W 5421, G 1–1–1) .. | 88 | 2 | |
| Grasby 51 × Major (W 7397, B 6–2–1–1–1) .. .. | 120 | 2 | | Major × Gallipoli (W 5817, J 5–2–2–2) .. .. | 88 | 2 | |
| Sailor's Luck .. .. | 119 | 1 | | Major × Gallipoli (W 5817, J 5–2–2–4) .. .. | 87 | 2 | |
| Baldmin .. .. | 117 | 1 | | Turvey .. .. .. | 86 | 10 | |
| Omrah .. .. .. | 116 | 3 | | Major × Ranee (W 4020, K 12–1) .. .. | 85 | 12 | |
| Ranee × Gallipoli (W 5899, J 1–1–2) .. .. | 111 | 4 | | Major × Gallipoli (W 5817, J 5–2–2–3) .. .. | 85 | 2 | |
| Ranee × Gallipoli (W 5899, J 1–1–2–4) .. .. | 111 | 2 | | Wannon .. .. | 84 | 5 | |
| Major × Ranee (W 4020, K 12–1, W 947, Q) .. | 109 | 2 | | Federation × Major (W 6914, N 3–3, W 500 n) .. | 83 | 2 | |
| Major × Gallipoli (W 5241, N 4–2–2) .. .. | 109 | 2 | | Gallipoli × Wannon (W 4073, L 10–1) .. .. | 79 | 2 | |
| Gluyas × Ranee (W 4035, K5–1) .. .. | 108 | 2 | | Gluyas .. .. .. | 79 | 11 | |
| Federation .. .. | 107 | 10 | | Sultan .. .. .. | 79 | 4 | |
| Bena .. .. .. | 105 | 4 | | Mogul .. .. .. | 77 | 9 | |
| Major × Ranee (W 4020, K 12–1, W 943, Q) .. | 104 | 2 | | Ghurka Seln. (W 839, Q 1–76–2) .. .. | 76 | 1 | |
| Ghurka Seln. (W 828, Q 1) | 103 | 1 | | Spelt .. .. .. | 75 | 2 | |
| Ranee × Gallipoli (W 5807, J 5–1–1) .. .. | 103 | 7 | | | | | |
| Ranee × Gallipoli (W 5899, J 5–1–1) .. .. | 101 | 2 | | | | | |
| Free Gallipoli .. .. | 100 | .. | | | | | |
| Major × Ranee (W 4020, K 12–1, W 955 Q) .. | 100 | 2 | | | | | |
| Ghurka × C.M.G. (W 5534, P 3–2–1) .. .. | 100 | 2 | | Kirley's Early .. .. | 73 | 1 | |
| Major × Currawa × Indian 4 × Federation (W 6331, F 3–1–1) .. .. | 99 | 2 | | Ghurka × C.M.G. (W 5544, P 7–3–2) .. .. | 73 | 2 | |
| Gallipoli × Austin (W 4015, L 5–1–2) .. .. | 99 | 2 | | Mac's White .. .. | 72 | 11 | |
| Ranee × Gallipoli (W 5806, J 3–2–1–5) .. .. | 98 | 2 | | Nizam .. .. .. | 71 | 10 | |
| Gallipoli × Austin (W 4105, L 5–1) .. .. | 97 | 2 | | Dan × Rajah (W 5493, P 3–1–4) .. .. | 71 | 2 | |
| Ranee × Gallipoli (W 5807, J 5–1–1–3–1) .. .. | 96 | 2 | | Improved Gluyas × Ranee (W 4212, L 2–1) .. | 69 | 7 | |
| Ranee × Gallipoli (W 5807, J 5–1–1–1–1) .. .. | 94 | 2 | | Sepoy × Gallipoli (W 4080, L 4–1–3) .. .. | 68 | 2 | |
| Baringa .. .. | 94 | 1 | | Improved Gluyas × Ranee 1h1 (W 4212, L 2–1–1–1) | 67 | 2 | |
| Major × Gallipoli (W 5817, J 5–2–2) .. .. | 92 | 6 | | Caliph .. .. .. | 67 | 4 | |
| Comeback × Gallipoli (W 4079, L 4–1–10) .. | 92 | 2 | | Viceroy × Federation × Yandilla King .. .. | 66 | 5 | |
| Waratah .. .. | 91 | 10 | | Penny .. .. .. | 66 | 10 | |
| Major .. .. .. | 91 | 10 | | Ranee 4H .. .. | 65 | 14 | |
| Major × Ranee (W 6021, K 1–1–1–2) .. .. | 90 | 2 | | Free Gallipoli × Sepoy (L 5053, B 2) .. .. | 64 | 4 | |
| Felix .. .. .. | 90 | 1 | | Sepoy × Gallipoli (W 4085, L 9–1–7) .. .. | 64 | 2 | |
| | | | | Ranee × Rajah (W 5013, E 4) .. .. .. | 63 | 11 | |
| | | | | Bobin .. .. .. | 62 | 10 | |

*VERY SUSCEPTIBLE.*

*SUSCEPTIBLE.*

TABLE. I.—FLAG SMUT INVESTIGATIONS—VARIETAL SUSCEPTIBILITY TRIALS—*continued.*

| Variety. | Susceptibility Figure. | No. of Results in Average. | |
|---|---|---|---|
| Ridit .. .. .. | 61 | 2 | *SUSCEPTIBLE.* |
| Warden .. .. | 61 | 8 | |
| Imperial Gluyas × Ranee (W 4212, L 2–1–6) .. | 60 | 2 | |
| Gallipoli 70G .. .. | 59 | 3 | |
| Sepoy × Gallipoli (W 4081, L 5–1–3) .. | 58 | 2 | |
| Yandilla King .. .. | 58 | 10 | |
| Ghurka × C.M.G. (W 5544, P 5–2–1) .. .. | 57 | 2 | |
| Currawa × Major × Gallipoli (W 7319, F 3–4–1–2) | 57 | 7 | |
| Rajah .. .. .. | 57 | 13 | |
| Rajah × Gallipoli (W 7491, H 2–1–2–3) .. .. | 54 | 4 | |
| Sepoy × Gallipoli (W 4084, L 9–1) .. .. | 53 | 2 | |
| Sepoy 324J .. .. | 52 | 13 | |
| Sepoy × Gallipoli (W 4081, L 6–1) .. .. | 51 | 5 | |
| Joffre .. .. .. | 48 | 10 | *MODERATELY RESISTANT.* |
| Currawa × Major × Gallipoli (W 5319, F 3–3–4) | 43 | 8 | |
| Webster .. .. | 40 | 2 | |
| Sepoy × Nabawa (W 5647, P 4–1–2) .. .. | 40 | 2 | |
| Sepoy × Gallipoli (W 4081, L 6–1–6) .. .. | 39 | 2 | |
| Sepoy × Gallipoli (W 4081, L 6–1–5) .. .. | 38 | 2 | |
| Currawa .. .. | 35 | 10 | |
| Ford .. .. .. | 34 | 10 | |
| Gallipoli × Wannon (L7001, J 26–3) .. .. | 30 | 2 | |
| Major × Ranee (W 4024, K 9–1) .. .. | 28 | 2 | |
| Sepoy × Dan (W 5497, P 3–3–2) .. .. | 25 | 1 | *RESISTANT.* |
| Ghurka × C.M.G. (W 5531, P 7–1–1) .. .. | 23 | 2 | |
| Totadgin .. .. | 23 | 4 | |
| Ghurka × C.M.G. (WL 5536, P 1–1L1) .. | 23 | 1 | |
| Rajah × Gallipoli (W 6491, H 2–4–3–4–6) .. .. | 22 | 1 | |
| Rajah × Gallipoli (W 6491, H 2–4–3–4) .. .. | 22 | 4 | |
| Telfords .. .. | 21 | 2 | |
| Rajah × Gallipoli (W 7491, H 2–4–3–4–1) .. .. | 21 | 2 | |
| Ghurka × C.M.G. (W 5545, P 4–1–1) .. .. | 19 | 2 | |
| Ghurka × C.M.G. (WL 5531, P 5–3L1) .. | 18 | 1 | |
| Ghurka .. .. | 17 | 14 | |
| Sword .. .. .. | 17 | 7 | |
| Rajah × Currawa (W 6405, O 2–1–1–2) .. .. | 17 | 1 | |
| Currawa Indian E × Telfords (W 7800, D 7–2–2) .. | 16 | 10 | *RESISTANT.* |
| Rajah × Currawa (W 6491, H 2–4–3–4–3) .. .. | 15 | 2 | |
| Ghurka Seln. 228T .. | 15 | 1 | |
| Gallipoli × Graham (L 5034, E 2a) .. .. | 13 | 6 | |
| Rajah × Nabawa (W 5665, P 1–1–1) .. .. | 12 | 2 | |
| Ghurka × C.M.G. (W 5537, P 4–2–2) .. .. | 11 | 1 | |
| Dundee .. .. | 11 | 8 | |
| Ghurka × C.M.G. (W 5543, P 4–2–1) .. .. | 10 | 1 | |
| Rajah × Gallipoli (W 6491, H 2–4–3–4–5) .. .. | 10 | 1 | |
| Bencubbin .. .. | 10 | 8 | |
| Sunset .. .. .. | 9 | 2 | |
| Dan .. .. .. | 9 | 8 | |
| Ghurka Seln. (W 595, O 5) | 9 | 1 | |
| Forward .. .. | 8 | 2 | |
| Nabawa × Improved Gluyas (W 5797, Q 1–3–2) .. | 8 | 1 | |
| Ghurka × C.M.G. (WL 5543, P 4–2–14) .. | 8 | 1 | |
| Currawa × Rajah (M 4041, S 3–2) .. .. | 7 | 1 | |
| Rajah × Nabawa (M 4024, S 4–2) .. .. | 6 | 1 | |
| Florence .. .. | 6 | 6 | |
| Sutton .. .. .. | 6 | 7 | |
| Carrabin .. .. | 5 | 8 | |
| Sepoy × Dan (W 5497, P 3–2–2) .. .. | 5 | 1 | |
| Geeralying .. .. | 4 | 10 | |
| Cedar .. .. .. | 4 | 10 | |
| Nabawa .. .. | 3 | 13 | |
| Red Rock .. .. | 3 | 8 | |
| Rajah × Gallipoli (W 7495, H 1–1–7–3–2–1) .. | 3 | 2 | |
| Rajah × Gallipoli (W 7495, H 1–1–7–3–2) .. .. | 3 | 12 | |
| Ghurka × C.M.G. (W 5530 P 3–2–1) .. .. | 3 | 2 | |
| Dindaloa .. .. | 1 | 10 | |
| Ghurka × C.M.G. (W 5530, P 2–2–2) .. .. | 1 | 2 | |

*Standard Errors.*—

(*a*) *Susceptible Varieties.*—(Susceptibility figures of 50 or over). For an average of 14 results = 6·05; where a smaller number of results is included in the susceptibility figures for any variety the standard error is proportionately larger, increasing to 22·7 for a single result.

(*b*) *Resistant Varieties.*—(Susceptibility figures less than 50). For an average of 14 results = 3·36: where a smaller number of results is included in the susceptibility of any variety the standard error is proportionately larger, increasing to 12·60 for a single result.

This calculation indicates the very low significance of a single result, particularly in the case of a susceptible variety. For the purpose of classifying the varieties according to their reactions to the disease, a susceptibility interval of 25 has been chosen. The standard error calculations indicate that to obtain satisfactory susceptibility figures for comparison of the relative susceptibilities of different varieties requires at least ten separate experiments for a variety in the susceptible group, while at least six results are required for a variety in the resistant group. These requirements have been adopted for the classification of named wheat varieties and resistant crossbreds. As a large majority of crossbreds tested are susceptible to the disease, considerable work would be involved in obtaining ten satisfactory results for each, which is not warranted unless such crossbreds finally become named varieties. In the case of these crossbreds, therefore, one or two results only are obtained to indicate their susceptibility to the disease. The susceptible crossbreds for which only one susceptibility figure is available have not been included in Table I. Those with two or more results are included as it is thought that they may be of some interest.

The results of these tests show a number of varieties which possess a high degree of resistance to flag smut. In addition, a high resistance is indicated in certain Ghurka (Currawa x Major x Gallipoli) and Rajah x Gallipoli crosses, which are proving promising in other respects. It is very interesting to note also the occurrence of very susceptible selections of the resistant variety Ghurka. These have susceptibility figures of 103 and 76 respectively as a result of one experiment, while the susceptibility figure of the parent variety is 17.

*Counting plants in flag smut tests. All infected plants in a row are pulled and recorded. The remaining apparently healthy plants are counted also.*

## *Effect of Flag Smut on Yield.*

A previous experiment conducted at the Mallee Research Station during 1933 (1) indicated the occurrence of suppressed infection in the parasitism of wheat by *Urocystis tritici*. This type of infection, which was not manifested in the production of typical sori, produced an appreciable effect on varieties which exhibited some degree of resistance to the disease. Compared with the susceptible varieties the relative loss in yield in the Ghurka variety was greater than could be accounted for on the basis of percentage of visible infection.

Further experiments designed to confirm these results were conducted at the State Experiment Farm, Rutherglen in 1934, and at the Mallee Research Station in 1935 and 1936. The results of these tests, which are referred to as No. 1, No. 2, and No. 3 are shown in Table II. All plots were 1/30th of an acre in area, each treatment being replicated five times in experiments No. 1 and No. 2, and four times in experiment No. 3. The 1934 experiment

*Flag smut trials, Walpeup—a general view.*

TABLE II.—ANALYSIS OF THE EFFECT OF VARIETY ON THE REDUCTION IN YIELD OF WHEAT CAUSED BY UROCYSTIS TRITICI.

| Treatment. | Susceptibility Figure. | Yield. | Infection. | Average Percentage of Infected Plants Totally Infected. | $K_1$ | $K_2$ |
|---|---|---|---|---|---|---|
| | | bus. per acre | % | % | | |
| ***Experiment No. 1.—Rutherglen, 1934.*** | | | | | | |
| *Free Gallipoli* .. .. | 100 | | | | | |
| Non-inoculated .. | .. | 18·04 | 1·5 | 0·0 | 0·0083 | 0·00029 |
| Inoculated .. .. | .. | 7·76 | 69·6 | 32·2 | | |
| *Ranee 4H* .. .. | 65 | | | | | |
| Non-inoculated .. | .. | 18·58 | 2·2 | 0·0 | 0·0048 | 0·00027 |
| Inoculated .. .. | .. | 14·53 | 46·8 | 20·6 | | |
| *Ghurka*— .. .. | 17 | | | | | |
| Non-inoculated .. | .. | 19 64 | 0·2 | 0·0 | 0·0228 | 0·01275 |
| Inoculated .. .. | .. | 18·96 | 1·7 | 14 6 | | |
| *Nabawa* .. .. | 3 | | | | | |
| Non-inoculated .. | .. | 17·05 | 0·4 | 0·0 | .. | .. |
| Inoculated .. .. | .. | 17·35 | 1·8 | 63·0 | .. | .. |
| Standard error .. .. .. .. .. .. .. | | | | | 0·0031 | .. |
| ***Experiment No. 2.—Walpeup, 1935.*** | | | | | | |
| *Free Gallipoli* .. .. | 100 | | | | | |
| Non-inoculated .. | .. | 21·70 | 5·4 | 25·3 | .. | .. |
| Light inoculation .. | .. | 21·46 | 14·9 | 25·2 | 0·0012 | .. |
| Heavy inoculation .. | .. | 15·74 | 60·7 | 29·8 | 0·0048 | 0·00018 |
| *Ranee* .. .. .. | 65 | | | | | |
| Non-inoculated .. | .. | 21·14 | 0·9 | 11·8 | .. | .. |
| Light inoculation .. | .. | 20·14 | 5·8 | 22·2 | 0·0094 | .. |
| Heavy inoculation .. | .. | 19·22 | 28·7 | 16·5 | 0·0032 | 0·00022 |
| *Currawa* .. .. | 35 | | | | | |
| Non-inoculated .. | .. | 21·60 | 0·4 | 33·3 | .. | .. |
| Light inoculation .. | .. | 21·68 | 1·7 | 0·04 | .. | .. |
| Heavy inoculation .. | .. | 21·74 | 10·3 | 9·9 | .. | .. |
| Standard error (for heavy inoculation) .. .. .. .. | | | | | 0·00033 | 0·00003 |
| ***Experiment No. 3.—Walpeup, 1936.*** | | | | | | |
| *Free Gallipoli* .. .. | 100 | | | | | |
| Non-inoculated .. | .. | 20·7 | 3·4 | 47·1 | .. | .. |
| Light inoculation .. | .. | 19·4 | 15·9 | 58·5 | 0·0050 | .. |
| Heavy inoculation .. | .. | 10·9 | 69·0 | 69·2 | 0·0073 | 0·00011 |
| *Ranee 4H* .. .. | 65 | | | | | |
| Non-inoculated .. | .. | 20·9 | 1·4 | 60·6 | .. | .. |
| Light inoculation .. | .. | 19·0 | 3·4 | 61·9 | 0·0434 | .. |
| Heavy inoculation .. | .. | 13·6 | 42·4 | 62·5 | 0·0084 | 0·00016 |
| *Ghurka* .. .. | 17 | | | | | |
| Non-inoculated .. | .. | 21·5 | 0·3 | 66·7 | .. | .. |
| Light inoculation .. | .. | 18·9 | 0·4 | 70·0 | .. | .. |
| Heavy inoculation .. | .. | 21·9 | 5·8 | 56·8 | .. | .. |
| Standard error (for heavy inoculation) .. .. .. .. | | | | | 0·00072 | 0·000017 |

at Rutherglen was similar to that previously described in that the yields from non-inoculated and heavily inoculated seed only were compared. In the following years it was hoped to study the effect of varying amounts of flag smut infection on the one variety, when the following treatments were employed for each variety :—

(*a*) Non-inoculated.
(*b*) Light inoculation (0·1 per cent. smut).
(*c*) Heavy inoculation (1·0 per cent. smut).

The general procedure of conducting these plots was similar to that described in a previous report. All these experiments were not entirely satisfactory as small local soil variations caused differences in individual plot yields which masked the small differences in yield due to inoculation, in the case of some of the more resistant varieties and lightly inoculated plots. It was not possible therefore to calculate a *K* (varietal constant) value for certain varieties. In the case of the lightly inoculated plots in experiments No. 2 and No. 3, although *K* values are given these figures are very unreliable and no conclusions can be drawn from them. The results of these treatments are included to present a complete report of the experiments and also to indicate the effect of spore load on the percentage infection. Comparing the infection which developed from light and heavy inoculation, it will be seen that increased spore load has a very marked effect in increasing flag smut infection.

In contrast with the light inoculations, the standard error calculations indicate that the *K* value for heavy inoculations is very much more reliable. This is to be expected as the differences in yield and infection are considerably greater and therefore not effected to the same degree by local soil variations.

The method of calculating the *K* value or varietal constant expressing the relative loss caused by flag smut has been described previously (1) but is repeated for convenience :—

If flag smut were entirely absent in the non-inoculated plots the varietal constant for reduction in yield would be obtained from the following expression :—

$$\begin{pmatrix}\text{Varietal}\\ \text{constant}\end{pmatrix} K = \frac{X - Y'}{A'} \times \frac{I}{X}$$

where $X$ = Yield of smut free plot.
$Y'$ = Yield of inoculated plot.
$A'$ = Percentage infection of inoculated plot.

In the above experiment, however, some natural infection was unavoidable, so that the yields of the non-inoculated plots were less than $X$.

On the assumption that within the range of infection produced in the above experiment, the reduction in yield of any particular variety is proportional to the infection, the yield of a smut-free plot may be calculated from the expression—

$$X = \frac{A'Y - AY'}{A' - A}$$

where $X$ = Yield of smut-free plot.
$Y$ = Yield of non-inoculated plot.
$A$ = Infection of non-inoculated plot.

A numerical value ($K$) expressing the effect of infection on the yield of each variety is therefore obtained as follows :—

$$K = \frac{Y - Y'}{(A' - A)} \times \frac{I}{X}$$

The values of $K$ obtained from this expression for each variety are shown in Table II., and may be regarded as an estimate for the loss in yield in bushels per acre per 1 per cent. of flag smut infection for every bushel of yield of the variety concerned.

On this basis of comparison it will be seen from experiment No. 1 that the $K$ value for the resistant Ghurka variety is very significantly greater than that for the two susceptible varieties Ranee and Free Gallipoli, and shows that the relative loss in yield due to flag smut is greater in the resistant variety. The results of this experiment confirm the effect of suppressed infection on the yield of flag smut resistant varieties, which was demonstrated in the 1933 experiment at Walpeup, and indicate that the losses in yield due to flag smut are greater than the occurrence of visible symptoms would indicate.

In experiment No. 2 the $K$ value for the Ranee variety was significantly less than that for Free Gallipoli, but in experiment No. 3 no significant difference could be established. This is due to the fact that the type of infection was not as severe in the former experiment as is indicated by the lower percentage of infected plants totally

***Sowing flag smut yield tests at Walpeup. Early and deep sowings are most favourable to the development of the disease.***

*Yield plots—flag smut investigations, Walpeup.*

infected. It is probable also that this fact is also the reason for the lower $K$ value for Free Gallipoli in experiment No. 2 as compared with experiment No. 3.

It appears, therefore, that a more ideal varietal constant which made some allowance for the severity of the flag smut symptoms in the visibly infected plants, would express more comparably the losses in yield due to flag smut under different conditions. Partially infected plants which produce one to several heads containing grain, obviously, increase the yield of the inoculated plots and decrease the $K$ value.

In an attempt to eliminate this variable a constant $K_1$ has been calculated from the following expression :—

$$K_1 = \frac{K}{P}$$

where $P$ = percentage of infected plants totally infected in the inoculated plot.

The values of $K_1$ obtained from this expression are shown in Table II.

These calculations express more clearly the effect of suppressed infection in experiment No. 1. As is to be expected, the $K_1$ values calculated for each replication of the resistant Ghurka variety varied very appreciably, due to the fact that the total number of infected plants involved in the samples from any plot was very small. As a result, one totally infected plant had a very big effect on the percentage of infected plants totally infected, and consequently on the $K_1$ value.

With the susceptible varieties it was found that the percentage of infected plants totally infected did not vary to any great extent so that the $K_1$ values for these were more uniform. The $K_1$ value calculations shown for experiment No. 2 indicate that the apparently significantly smaller loss in yield in Ranee as compared with Free Gallipoli is misleading. The significantly higher $K_1$ value for this variety in experiment No. 3 shows that this variety does exhibit the phenomenon of suppressed infection at Walpeup when compared with Free Gallipoli. This is to be expected as the susceptibility figures for these varieties shown in Table II., indicate that Ranee is the more resistant variety.

Considered as a whole, these experiments have shown the great difficulty which is experienced in demonstrating the effect of suppressed flag smut infection on the yield of the resistant wheat varieties. They offer however, a reliable indication of the magnitude of the losses in yield due to severe flag smut infection of susceptible varieties, particularly in the Victorian Mallee.

### *Reference.*

(1) Miller, W. B. and Millikan, C. R.—"Investigations on Flag Smut of Wheat Caused by *Urocystis tritici* Koern." J. Dept. Ag., Victoria, 33, 365–380, 418–432, 1934.

## *Orchard and Garden Notes*

(*Continued from page* 513).

The lures will indicate the presence and the abundance of the moths, and the time to spray should be judged by these flights. A spray should usually be put on, from about ten days after the peak period of flight.

It is most desirable to control the spring brood of the moths, otherwise the control of the second brood will be made more difficult. In order to achieve this the timing of the sprays must be correct and accurate. Apart from this, all sprays must be thorough, so that a good cover may be maintained. Excessive spraying should be avoided, as a big "run off" will not make for effective results. Growers should turn to this *Journal* for August and September for records and results of the demonstration work.

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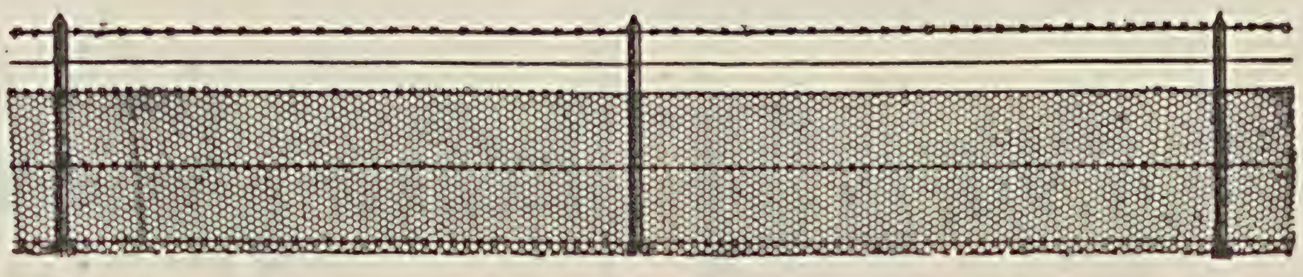

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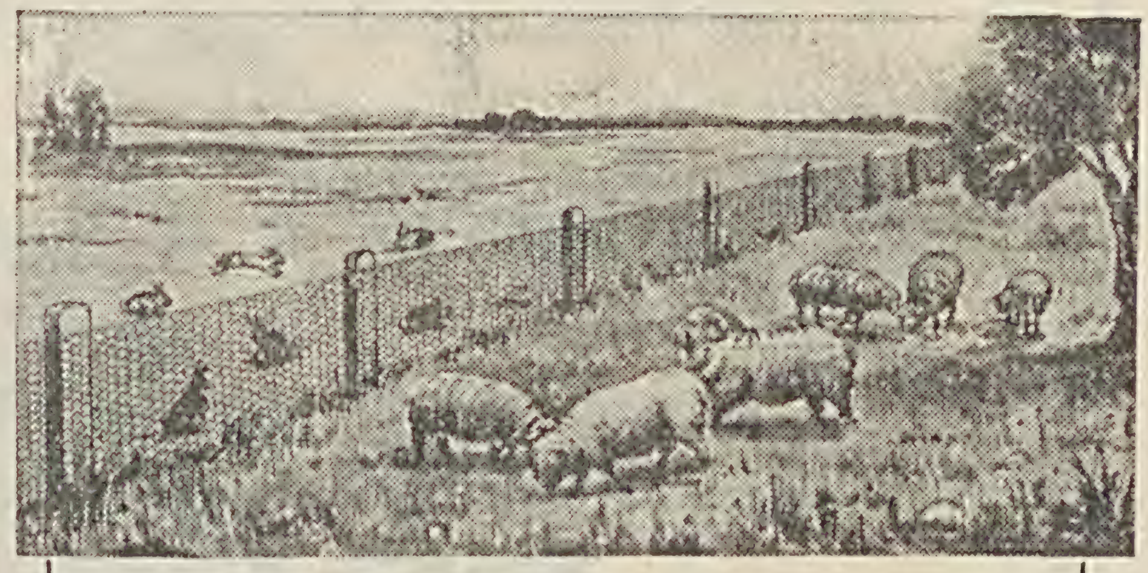

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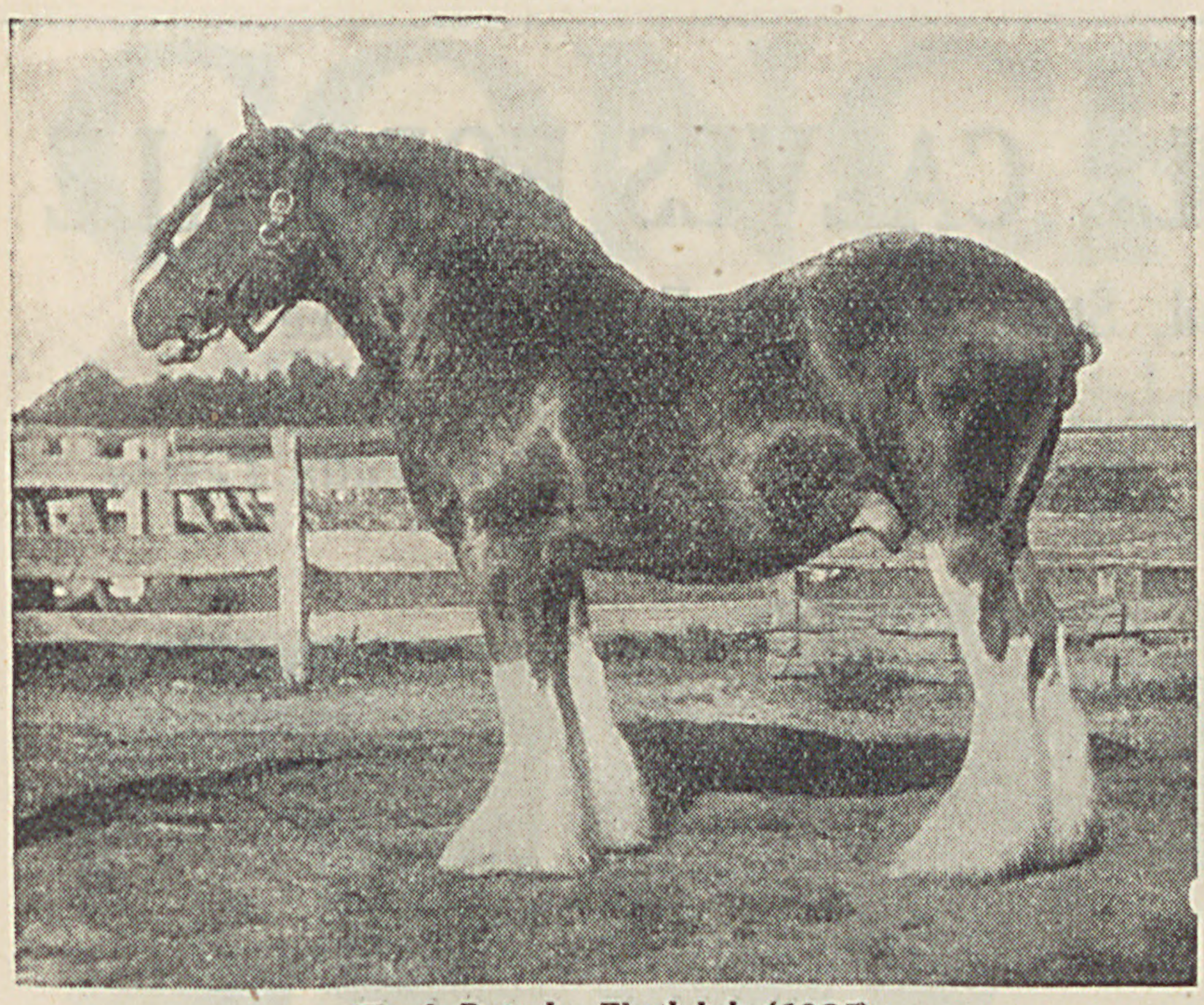

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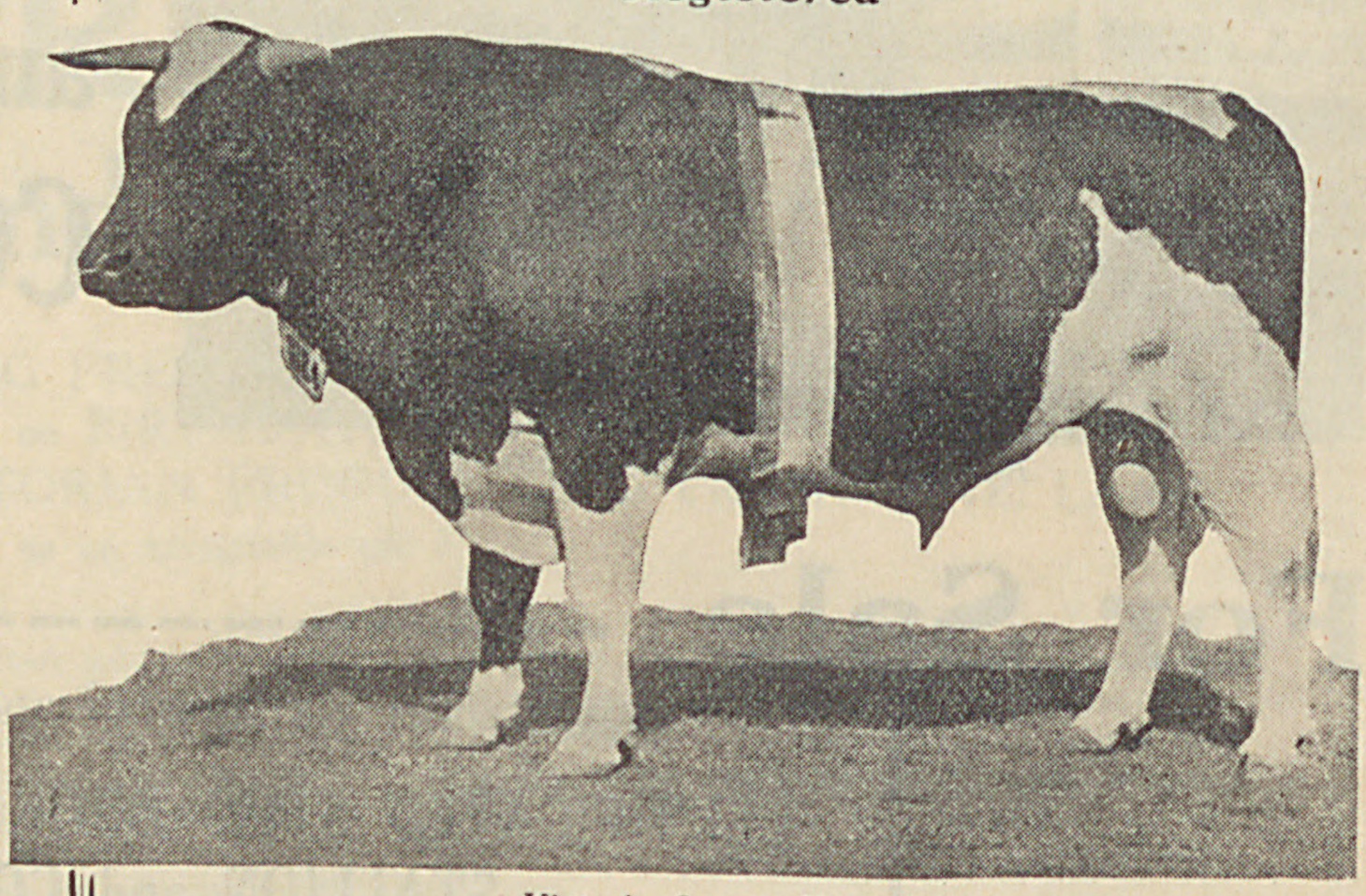

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Victoria Joyous Piebe has produced 546 lb. butter-fat in 273 days.
*Price:* **21 guineas** f.o.r. Werribee

3. **VICTORIA CONDUCTOR** (C.R.) *Born 13th January, 1937*
*Sire:* Rupertswood Inka Jo (1732) *Dam:* Victoria Soprano (3265)
Victoria Soprano produced 496 lb. butter-fat in 273 days.
*Price:* **20 guineas** f.o.r. Werribee

4. **VICTORIA DANCING BOY** (C.R.) *Born 19th July, 1937*
*Sire:* Rupertswood Inka Jo. (1732) *Dam:* Victoria Dancing Girl (Vol. 14)
Victoria Dancing Girl produced 319 lb. butter-fat in 273 days as Jr. 2.
4.03% test.
*Price:* **11 guineas** f.o.r. Werribee

*For further particulars apply to*

**The Director of Agriculture, Melbourne,**

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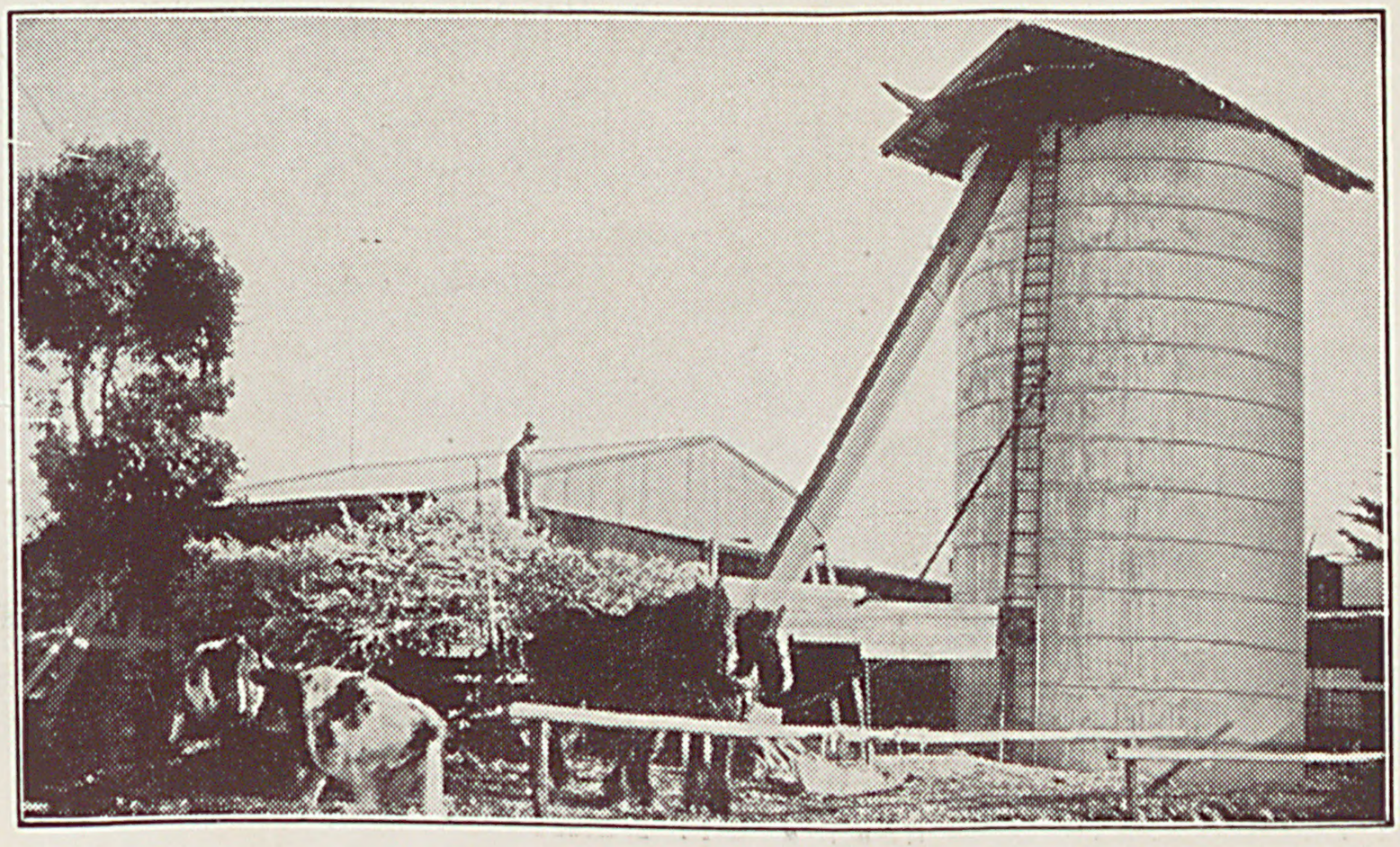

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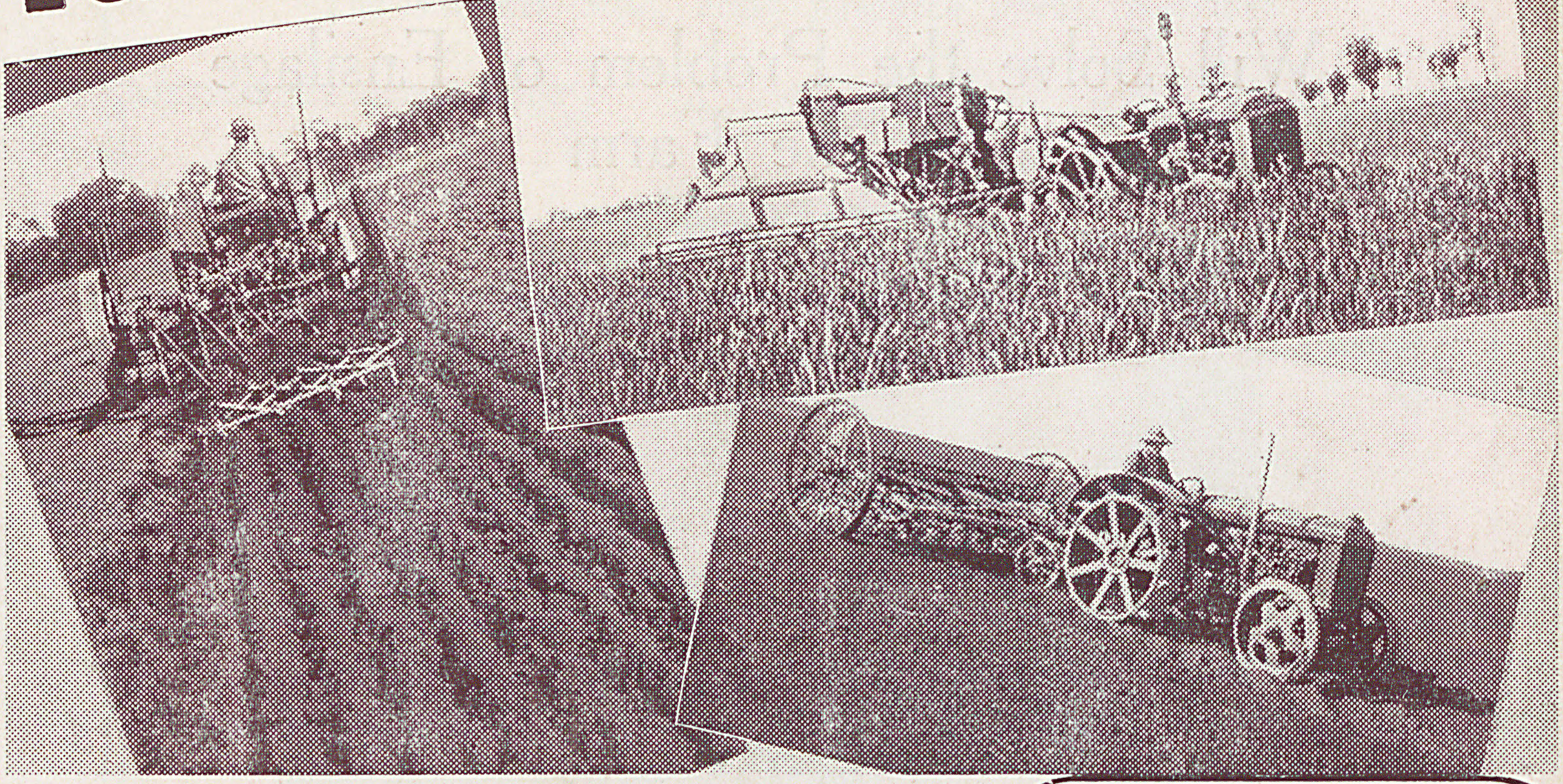

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